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1990 NOAA AUTHORIZATION

HEARING

BEFORE THE

SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

APRIL 4, 1989

[No. 44]

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1990 NOAA AUTHORIZATION

TUESDAY, APRIL 4, 1989

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE
RESEARCH AND ENVIRONMENT,
Washington, D.C.

The subcommittee met, pursuant to call, at 9:35 a.m., in Room 2318, Rayburn House Office Building, Hon. James Scheuer (chairman of the subcommittee) presiding.

Mr. SCHEUER. Good morning. The Subcommittee on Natural Resources, Agriculture Research and Environment will come to order.

This morning we are going to consider the NOAA budget. We will be reviewing the 1990 budget request for NOAA and asking some questions, I'm sure, of Dr. Evans and the folks he has brought with him. We're particularly happy to welcome Kent Burton, with whom we've had an excellent working relationship in the past, and whose counsel and advice, even in the most dire circumstances, has always been helpful and life-saving.

All right. I'm going to call on my colleague, the Ranking Minority Member of this subcommittee, the Honorable Claudine Schneider of Rhode Island, for some remarks.

Ms. SCHNEIDER. Thank you, Mr. Chairman.

I think as we all know, NOAA is an agency with a mission that is indispensable to our understanding and also to the management of the world's resources. But the portion of the agency that's under consideration today relates to the Office of Atmospheric Research, its satellite programs, and also the National Weather Service.

Despite the growing awareness on the part of the mass populace, there have been some overall funding problems that we've experienced over the last couple of years, and I think that the current budget request for 1990 offers a mixed picture.

The global change element is—I think it's encouraging that the administration has requested a substantial increase in the global change program. We're looking at fiscal '89, from $9 million in '89 to $20 million in 1990. This program includes studies on the greenhouse effect. I think there are very few issues that would affect the state of the world as drastically as the extensive challenge of global warming. When you consider that 15 of the world's largest 25 cities are on the coast, and that 75 percent of the population of the United States lives within 50 miles of the ocean, then we had better have the monitoring expertise and the knowledge to project what kind of challenges we may face. In addition to flooding, global

warming could result in drought and severe storms, permanently changing certain climate patterns.

Secondly, the National Weather Service is also going to be discussed here today, and I think that the future funding for the Weather Service is less secure. Earlier this year, the administration was considering closing dozens of weather stations throughout the country, and I wholeheartedly opposed the closing of these stations, and I will continue to do so until we can show that there will be no substantial loss of essential coverage.

The various offices at airports all around this country are particularly important, and when we look at the statistics from 1980 to 1984, we see that weather was cited as a factor in a total of one-third of all fatal air carrier accidents. In addition, agency figures indicate that storms in coastal areas alone result in the loss of hundreds of lives and millions of dollars a year. So, needless to say, the activities of the National Weather Service and the funding for those services are of critical importance to this Member and I'm sure to most members of this committee.

Then finally, Landsat. The value of the continued operation of the Landsat satellites is significant. The fact that these satellites watch over the state of the world's resources, we would lose sight of vital events, ranging from agricultural production to mineral exploration, to the spread of tropical deforestation, and I do hope that the administration will be successful at working with Congress and other interested parties to devise an equitable solution to this particular situation.

So I welcome the witnesses here this morning and I look forward to their testimony, particularly their comments on those three elements that I have cited—the global change, the National Weather Service, and also Landsat.

Thank you, Mr. Chairman.

[The prepared statement of Hon. Claudine Schneider follows:]

HONORABLE CLAUDINE SCHNEIDER (R-RI)

OPENING STATEMENT

HEARING NOAA BUDGET REQUEST FOR FY 1990

APRIL 4, 1989

NOAA IS AN AGENCY WITH A MISSION INDISPENSABLE TO THE ADEQUATE UNDERSTANDING AND MANAGEMENT OF OUR WORLD'S RESOURCES. THE PORTION OF THE AGENCY UNDER CONSIDERATION IN TODAY'S HEARING INCLUDES THE WORK OF NOAA'S OFFICE OF ATMOSPHERIC RESEARCH (OAR), ITS SATELLITE PROGRAMS (NESDIS), AND THE NATIONAL WEATHER SERVICE (NWS).

DESPITE A GROWING AWARENESS OF THE IMPORTANCE OF CARING FOR THE ENVIRONMENT, OVERALL FUNDING FOR THESE PROGRAM HAVE BEEN

STEADILY DECLINING IN REAL TERMS IN RECENT YEARS. THE CURRENT BUDGET REQUEST FOR FY 1990 OFFERS A MIXED PICTURE.

GLOBAL CHANGE

IT IS ENCOURAGING THAT THE ADMINISTRATION HAS REQUESTED A SUBSTANTIAL INCREASE IN THE GLOBAL CHANGE PROGRAM, FROM $9 MILLION IN FY 1989 TO $20 MILLION IN FY 1990. THIS PROGRAM INCLUDES STUDIES ON THE GREENHOUSE EFFECT:

- FEW ISSUES COULD AFFECT THE STATE OF THE WORLD AS DRASTICALLY AS EXTENSIVE GLOBAL WARMING: 15 OF THE WORLD'S LARGEST 25 CITIES ARE ON THE COAST; 75% OF THE POPULATION OF THE U.S. LIVES WITHIN 50 MILES OF THE OCEAN.

- O IN ADDITION TO FLOODING, GLOBAL WARMING COULD RESULT IN DROUGHT AND SEVERE STORMS, PERMANENTLY CHANGING CLIMATE PATTERNS.

NATIONAL WEATHER SERVICE

HOWEVER, THE FUTURE OF FUNDING FOR THE WEATHER SERVICE IS LESS SECURE. EARLIER THIS YEAR, THE ADMINISTRATION WAS CONSIDERING CLOSING DOZENS OF WEATHER SERVICE STATIONS THROUGHOUT THE COUNTRY. I OPPOSED THE WHOLESALE CLOSING OF STATIONS THEN, AND WILL CONTINUE TO, EXCEPT WHERE IT CAN BE SHOWN THERE WILL NO LOSS OF ESSENTIAL COVERAGE.

- O OFFICES AT AIRPORTS ARE ESPECIALLY IMPORTANCE; FROM 1980 TO 1984, WEATHER WAS CITED AS A FACTOR IN A THIRD OF ALL

FATAL AIR CARRIER ACCIDENTS.

O IN ADDITION, AGENCY FIGURES INDICATE THAT STORMS IN COASTAL AREAS ALONE RESULT IN THE LOSS OF HUNDREDS OF LIVES AND MILLIONS OF DOLLARS A YEAR.

LANDSAT

FINALLY, I WOULD LIKE TO NOTE THE VALUE OF THE CONTINUED OPERATION OF THE LANDSAT SATELLITES. LANDSAT PROVIDES US WITH AN EYE THAT WATCHES OVER THE STATE OF THE WORLD RESOURCES. WITHOUT LANDSAT, WE WOULD LOSS SIGHT OF VITAL EVENTS RANGING FROM AGRICULTURAL PRODUCTION, TO MINERAL EXPLORATION, TO THE SPREAD OF TROPICAL DEFORESTATION. I HOPE THE ADMINISTRATION IS SUCCESSFUL AT WORKING WITH CONGRESS AND

OTHER INTERESTED PARTIES TO DEVISE AN EQUITABLE SOLUTION TO THIS SITUATION.

Mr. SCHEUER. Thank you, Madam Schneider.

Well, we're happy to have you here, Dr. Evans, and we hope that this will be a productive, productive and constructive hearing.

The administration has requested a budget of $718 million for fiscal year 1990 for the NOAA programs that are under the jurisdiction of the Science Committee. Now, that represents a cut of about $97 million, or in the neighborhood of 15, 16 percent, from the '89 appropriations bill, and is $162 million less than the authorization for fiscal '89. These are massive cuts, and they are proposed at a time when NOAA is already experiencing a significant budget shortfall in the current fiscal year. Thus, we have already witnessed the spectacle of proposals first to cut up to 132—to close down up to 132 weather stations—and to terminate operations of Landsat 4 and 5.

Now, these very destructive proposals, in our opinion, may have been thwarted and overturned by the Congress. We're very much interested in hearing what your plans are to fund these activities and how this situation can be reconciled with the further budget cuts proposed in the fiscal 1990 budget.

Now, you have assured us in your testimony, which is replete with encouraging rhetoric, Dr. Evans, but is in deficit in terms of specific funding proposals to undergird your confidence and almost euphoria of the continuation of these programs. We really want to know some specifics. When you talk about continuing Landsat, you say the administration is committed to continuing operations of Landsat 4 and 5 until a review of the National Space Council is finished. Well, as you very well know, you have been passing the hat among other Federal agencies to eke out a few more months of survival for Landsat 4 and 5, and I think you've got them funded up to about July 1st, something like that, June or July 1st. How are you going to solve this time frame problem? Are you going to force this review of Landsat 4 and 5 that's being undertaken by the National Space Council to be finished in order for us to have some—in order for you to make a request for funding?

I mean, what are you telling us? Are you telling us that a thoughtful, scholarly, in-depth review is going to be ordered to take place in 30 or 60 or 90 days? Or are you going to provide such funding as may be necessary beyond July to continue Landsat 4 and 5 until the review is finished? We would like to have a professional, responsible review by the National Space Council.

We think it's really a denigration of the purpose of such a review by saying you chaps have to come in with something in 60 days because, beyond that, if we decide to continue Landsat 4 and 5, if your review takes more than 60 days, we're not going to be able to have time to ask for a supplemental appropriation or doing anything else before the possible demise of Landsat 4 and 5. We want some specific answers. And I hope that you won't be telling us that you're going to rush the National Space Council to complete its review in an untimely fashion, without having the time or the energy to do what all of us want, which is a thoughtful, in-depth, professional review that would give us guidance in terms of how to act.

We are pleased that your U.S. global change research program is apparently being protected. There are a number of constructive

things in your testimony. But there are too many gaps and too many specifics absent and lacking. You talk about—well, you say there's been—yes, you say there's a commitment to keep the weather stations going and not to close down any weather stations in 1989. Yet, by my calculations, our committee staff's calculations, we need approximately $25 million just to keep our lip above water. Where is that going to come from, to continue operations at the level in which they are now being carried on.

I don't know if it would be fair to say that your testimony, having some encouraging things in it, nevertheless has a large dimension of glittering generalities and innocuous platitudes. That's what my father used to say when I would hand him an English paper for high school. If he had lived 50 years later, he would have said "Where's the beef?" But he didn't. He used to say, "Jim, that's a lot of glittering generalities and innocuous platitudes. When are you going to tell us something?"

All right. So we look forward to your testimony with keen anticipation, and we hope you will fill in some of the gaps on the specifics.

We have a large, encouraging turnout of Members today. Claudine Schneider we have already heard from. Congressman Paul Henry.

Mr. HENRY. I have no opening statement.

Mr. SCHEUER. All right. Congressman David Skaggs of Colorado.

Mr. SKAGGS. Good morning, Mr. Chairman. I don't have any opening statement.

Mr. SCHEUER. Okay, thank you.

All right. Congressman Sid Morrison.

Mr. MORRISON. No statement, Mr. Chairman, thank you.

Mr. SCHEUER. Congressman Tim Valentine.

Mr. VALENTINE. Mr. Chairman, thank you.

I have an opening statement, which I would like to submit for the record, and also, Mr. Chairman, I have a statement from our colleague, Congressman David Price of North Carolina, who is unavoidably detained and cannot attend this function, but he asked that I submit an opening statement of his for the record.

Thank you, Mr. Chairman.

Mr. SCHEUER. Very good. Without objection, so ordered.

[The prepared statements of Hon. Tim Valentine and Hon. David Price follow:]

Statement of the Honorable Tim Valentine
before the Subcommittee on Natural Resources,
Agriculture Research and Environment
FY 1990 National Oceanic and Atmospheric
Administration Budget
April 4, 1989

Thank you, Mr. Chairman, for convening this hearing on a subject that has become very important to the people of North Carolina and to me -- the reauthorization of the National Oceanic and Atmospheric Administration (NOAA) budget for FY 1990.

I am particularly concerned about two areas today: the Administration's proposed FY 1990 budget and the reorganization of the National Weather Service (NWS).

In my opinion, the proposed budget reflects the continuing and unfortunate view that the major programs under the auspices of NOAA should be severely reduced, while others are relegated to low-priority status or terminated altogether, transferred to local and state governments, or put in the hands of the private sector.

How can NOAA fulfill its obligations and responsibilities to the taxpayers of this country if hiring freezes are imposed and sorely needed staff positions remain unfilled or maintenance on equipment continues to be deferred? How can NOAA continue its civilian land remote sensing capabilities, which was "zeroed-out" in FY 1989? The entire nation, if not the world, has come to depend on data gathered through Landsat. Only through the strong urging of the Congress did the Administration agree to the continuation of Landsat Four and Five by obtaining commitments from various government agencies to prevent termination of the satellite program. It is ironic that the budget request for FY 1990 includes no money for this operation.

Although there has been an increase of $11 million in NOAA's program of climate and global change over FY 1989, it is not sufficient for NOAA to achieve its long term goal of establishing a national information service based on reliable predictions of changing global climate.

I am pleased that NOAA has submitted to the Congress its proposal for modernizing the National Weather Service (NWS). The plan is particularly important to my constituents and me since parts of the Second District have been devastated by two killer tornados within the past five years. In both instances, there was demonstratable and urgent need for upgrading the weather radar and prediction systems, not only in the Second District but throughout the country. In fact, several steps toward that goal have been taken in North Carolina, and NEXRED is to be installed in the area in 1992. However, I have learned from some reports that this technology is not yet quite proven and has yet to be tested outside of the contractor's facilities. It is also my understanding that the actual first real-life tests using this technology will not begin until the middle of this month.

Additionally, I am concerned about the reliability of and range of the radar and its ability to distinguish between certain tornados and mesocyclones.

I am also concerned about the effectiveness of other parts of the plan, such as ASOS, the Automated Surface Observation System, which is scheduled to be installed at numerous locations and supposedly automate the work currently being performed by technicians. We need to know the test results of this program and what further research and development, or improvements, are needed?

I have supported efforts to modernize that National Weather Service and will continue to do so. We need to upgrade our facilities and replace the antiquated and outmoded equipment of the 1950's, but we should not do so with undue haste. NEXRED is touted as the ultimate, state-of-the-art technology in weather forecasting. It is also very expensive. I am as concerned about the budget deficit as any member, and we need to examine the implications of not only the reorganization of the National Weather Service, but the technology that is to be used, to be sure that we are receiving our money's worth.

With that, Mr. Chairman, I look forward to hearing from our panelists today.

OPENING STATEMENT OF
REPRESENTATIVE DAVID PRICE
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH,
AND ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

Mr. Chairman, as you know, on March 3rd this subcommittee conducted a field hearing in Raleigh, North Carolina to examine the National Weather Service's ability to forecast tornados and issue severe storm warnings. Representative Tim Valentine and I asked for the hearing after a November 28th tornado tore through nine North Carolina counties, most of them in our congressional districts, killing four people, injuring 157 others and damaging approximately 1,000 homes and businesses. No warning or watch was issued by the National Weather Service prior to the touch-down of the tornado and the weather radar at the Raleigh-Durham forecast office was inoperative at the time of the disaster.

The subcommittee heard from several witnesses who surveyed the damage caused by the November 28th tornado and assessed the performance of the National Weather Service in forecasting severe weather and communicating tornado warnings efficiently and effectively. We also heard from several representatives from the National Weather Service, including Frederick Ostby, Director of the National Severe Storm Forecasting Center in Kansas City, Ronald McPherson, Deputy Director of the National Weather Service, and Robert Muller, Meteorologist in Charge of the Raleigh-Durham Weather Service. Their testimony provided disturbing evidence that the failure of the Raleigh-Durham weather radar is indicative of deeper problems at the National Weather Service. The agency's budget is stretched to the limit. They are suffering from serious personnel shortages, a lack of available spare parts, and outdated and obsolete technology.

With the announcement by Secretary Mosbacher that approximately 70 weather stations will not be closed this year, and the National Weather Service's recently submitted plan to Congress to modernize and upgrade its weather detection equipment, the administration has taken a step in the right direction. However, the Administration and the Congress must give renewed attention to the modernization plans and budgetary needs of the National Weather Service. The people of North Carolina, who experienced yet another tornado last week, know just how important it is to upgrade the National Weather Service's capacity and performance.

I commend the Chairman for conducting this hearing today and I look forward to working with this subcommittee on this critical matter.

Mr. SCHEUER. Congressman Chris Shays.

Mr. SHAYS. No statement, Mr. Chairman.

Mr. SCHEUER. All right. Congressman Lamar Smith of Texas.

Mr. SMITH. No comments. Thank you, Mr. Chairman.

Mr. SCHEUER. All right. Thank you, Congressman.

All right. We've all gotten off our chest whatever we needed to get off our chest, so we're happy to recognize you, Dr. Evans, and yield such time as you may need.

STATEMENT OF WILLIAM E. EVANS, ADMINISTRATOR AND UNDER SECRETARY FOR OCEANS AND ATMOSPHERE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE; ACCOMPANIED BY KENT BURTON, ASSISTANT SECRETARY; ELBERT W. FRIDAY, JR., ASSISTANT ADMINISTRATOR FOR WEATHER SERVICES; THOMAS N. PYKE, JR., ASSISTANT ADMINISTRATOR FOR ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICES; AND ALAN THOMAS, ACTING ASSISTANT ADMINISTRATOR FOR OCEANIC AND ATMOSPHERIC RESEARCH

Dr. EVANS. Thank you very much, Mr. Chairman, Congresswoman Schneider, members of the subcommittee. We would like to thank you for the opportunity to at least hopefully provide you with some clarification of some of the questions that you have raised, especially in those areas—again, I can give you another one of those platitudes, but it's a very serious one.

We do take the concerns that you have stated very seriously. As has been stated several times by other members of the administration who have appeared before this committee and others, the President and the administration are very, very interested and working very closely with Congress. I am very pleased—during my tenure at NOAA, I think we have had a very good relationship with this committee and others, and have tried to work with them to solve the—

Mr. SCHEUER. You have, indeed, Dr. Evans. I think the statement you just made is a serious statement. It's not a platitude. The phrase "a serious platitude" is an oxymoron.

(Laughter.)

But I really take that to be a serious statement—

Dr. EVANS. Like the Postal Service.

Mr. SCHEUER. Yes. And I can only footnote that with my hope and expectation that you'll answer some of the specific questions we have addressed.

Dr. EVANS. Thank you, Mr. Chairman. That's one of the reasons that I—this is not meant to be a cast of thousands here, but I did bring with me this morning the people that I think are on the front line working on these issues. Mr. Tom Pyke, who is the Assistant Administrator for the Environmental Satellite, Data and Information Services, who is working very vigorously with the—in fact, is actually our representative on the Space Policy Committee (National Space Council) which, by the way, is meeting right now. In fact, Tom sent his deputy to meet with the Vice President and other members of that committee this morning.

We have Dr. Joe Friday, who is the Assistant Administrator for Weather Services, and we have Dr. Alan Thomas, Acting Assistant Administrator for Oceanic and Atmospheric Research, and, of course, my Assistant Secretary, Mr. Kent Burton.

Mr. SCHEUER. I would have to say that we've had excellent relations with Kent Burton and Mr. Pyke. We worked hard, with great anxiety and sympathy, observing Mr. Pyke trying to engage in mouth-to-mouth resuscitation of this asphyxiating babe, and what we would like to know is has he brought it to life, how successful was this effort to pass the hat about, how many months of extended life do we get from that mouth-to-mouth resuscitation effort; does it give a reasonable period of time for the National Space Council to give us some thoughtful, in-depth, professional views, observations, conclusions, recommendations; or, if it's going to take them longer, how are we going to—are we going to ask Mr. Pyke and his colleagues to engage in more mouth-to-mouth resuscitation to keep that babe alive until such time as the National Space Council does give us its considered recommendations.

So, anyway, we want to congratulate you on the quality of your staff, yourself. We've had excellent relations up to now, and our concern is not that we love you less but that we love you more, and we are great supporters of your programs and we want to see them continue their superb record of service and accomplishment. We'll try not to interrupt you as you go ahead with your statement.

Dr. EVANS. Thank you, Mr. Chairman.

What I would like to do, I have moved away from my testimony, which you have for the record. There's no need to really go through that in detail. What I would like to do at this time is to ask Mr. Pyke to bring you up-to-date on where we are with the Policy Council, the National Space Council, as of the very last meeting we had, and the evaluation that we've had now on not only the Landsat 4/5 program but Landsat 6, and with what the plans are for Landsat on down the line after the Landsat 6. So I think Tom certainly has the most up-to-date information and I think that's what this committee needs.

So at this time, with your permission, Mr. Chairman, I would like to turn the microphone over to Mr. Pyke.

[The prepared statement of William E. Evans follows:]

TESTIMONY OF

DR. WILLIAM E. EVANS
UNDER SECRETARY FOR OCEANS AND ATMOSPHERE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

UNITED STATES HOUSE OF REPRESENTATIVES

APRIL 4, 1989

Mr. Chairman and Members of the Subcommittee:

Thank you for providing me the opportunity to discuss the Fiscal Year 1990 budget request for the atmospheric and satellite programs of the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce.

I am accompanied this morning by Dr. Elbert W. Friday, Jr. Assistant Administrator for Weather Services; Mr. Thomas N. Pyke, Jr., Assistant Administrator for Environmental Satellite, Data, and Information Services; and Dr. Alan Thomas, Acting Assistant Administrator for Oceanic and Atmospheric Research.

Mr. Chairman, I would like to summarize briefly some of the highlights of NOAA's Fiscal Year 1990 program budget, after which I would be pleased to answer any questions you might have.

- During Fiscal Year 1990, NOAA will continue progress toward a modernized and restructured National Weather Service

(NWS). The budget continues procurement of the automated surface observing system (ASOS), production of the next generation radar (NEXRAD), development of the advanced weather interactive processing system (AWIPS), and seventh generation computer capability for the National Meteorological Center. These systems will help us modernize the NWS with the latest technology and science to improve NOAA's severe weather and flood warnings and forecasts.

- Secretary Mosbacher recently announced that no NWS weather stations will be closed in fiscal year 1989 or 1990. This policy will enable NOAA to consider future NWS restructuring, including station closures and consolidations, in the context of improved services due to modernization, pursuant to Public Law 100-685 and NOAA's "Strategic Plan for the Modernization and Associated Restructuring of the National Weather Service", which recently was transmitted to the Congress.

- NOAA will continue procurement of the next generation geostationary satellite series -- GOES I-M. NOAA also will continue procurement of commercial launch services for the series. GOES I-M will provide geostationary satellite coverage for weather forecasts and warnings through the 1990's. The first satellite in the series, GOES-I, will be launched during Fiscal Year 1990. GOES-I will replace

GOES-6, which failed in January 1989, and will restore two-GOES coverage. Over the past year, NOAA and NASA have conducted an effort to contain costs of the GOES I-M series. NOAA has instructed NASA to negotiate a cap on the spacecraft contract in order to limit cost growth.

- The Fiscal Year 1990 budget continues funding for the polar-orbiting environmental satellite program. The budget includes funding for integration, test, and launch of NOAA-D, NOAA-I, and NOAA-J. NOAA also will continue fabrication of the NOAA K-L-M series, which will provide coverage into the late 1990's. The budget request provides funding for polar-orbiting satellites to be launched alternately into both morning and afternoon orbits at 15-16 month intervals.

- A funding increase of $16.5 million is requested to complete procurement of the space segment of Landsat 6, which is scheduled for a July 1991 launch. EOSAT, NOAA's Landsat commercialization contractor, will be responsible for Landsat 6 operations. The National Space Council is conducting a review of Landsat, and, as the Committee knows, the Administration is committed to continuing operations of Landsats 4 and 5 until that review is completed.

- A funding increase also is requested for NOAA's Climate and Global Change Program. In order to respond to the unique NOAA responsibilities in the interagency U.S. Global Change

Research Program, NOAA's Fiscal Year 1990 program provides additional resources for high priority projects, including:

- Long-term observations, emphasizing ocean monitoring, global sea level, and stratospheric change;
- Research on physical and biogeochemical processes in the climate system, including the Tropical Ocean Global Atmosphere (TOGA) and Radiatively Important Trace Species (RITS) programs, and the global hydrological cycle;
- Climate diagnostics and prediction efforts to develop and apply techniques for detecting natural and human-induced change and to develop, test, and apply predictive models; and
- Climate data services for the acquisition, development, maintenance, and distribution of high quality, long-term data bases and related climate information.

o NOAA will procure a seventh generation supercomputer for NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, New Jersey. The new supercomputer will increase GFDL's computing capacity by a factor of ten, and will improve the understanding and forecasting of the atmosphere and oceans as required by NOAA's Climate and Global Change Program and Coastal Ocean Program.

- NOAA will continue leading edge research of environmental issues. For example, NOAA scientists were a major part of an expedition this part winter to investigate the chemistry of the Arctic stratosphere to determine if processes similar to those causing the Antarctic ozone hole were present over the Arctic. Preliminary results indicate that there is a perturbed chemistry similar to that in Antarctica; thus, there is potential for seasonal ozone destruction in the Arctic stratosphere. NOAA scientists will continue to be at the forefront of understanding such topical environmental issues.

Mr. Chairman, I believe that this proposed budget is sufficient to support NOAA's atmospheric and satellite programs. Although the Nation is faced with serious budgetary problems which cause us to restrict Federal spending, the Fiscal Year 1990 NOAA budget continues our National Weather Service modernization, satellite system procurement and services, and important atmospheric research programs. I am pleased that the budget includes substantial funding increases for Landsat commercialization and for NOAA's Climate and Global Change program, both of which the Congress in general, and this Committee in particular, have strongly supported.

Again, I thank the Committee for inviting me to discuss the Fiscal Year 1990 budget for these programs, and I would be pleased to answer any questions you may have.

Mr. SCHEUER. Fine. We welcome you here, Mr. Pyke. Please take such time as you may need.

Mr. PYKE. Thank you, Mr. Chairman.

I am pleased to report that we have followed up, as we stated to this committee a few weeks back, and that the National Space Council has begun a policy review of the Landsat Program. This has followed also the commitment that we made to keep Landsats 4 and 5 alive and kicking, at least until the completion of that policy review.

We were able to—

Mr. SCHEUER. Excuse me. You heard the questions just raised in my mind. Are they going to be forced into a very tight time frame to make their review, quicker than you and I privately would agree would be necessary to a thoughtful, professional review, and if they're not going to be forced into an overly tight timetable, and they're going to be allowed to take four, five or six months or more, how is the funding going to keep this babe alive until they've come in with their recommendations and conclusions? What arrangements have you made for funding until such time as a proper professional review can be made?

Mr. PYKE. Mr. Chairman, thanks, in part, to the foresight of this committee, we have been working for the past year developing a background of information, the contractor studies that were performed, the reviews within NOAA and the Commerce Department that are all serving as input to the National Space Council review. Therefore, it is very probably that that review can be completed quickly and thoroughly. And as Dr. Evans stated earlier, it is underway as we speak, and we expect to have results in adequate time for consideration by the Congress.

The funds that we have in hand will enable us to keep Landsats 4 and 5 alive until the completion of that review.

Mr. SCHEUER. Well, that's encouraging. I, myself, think there's enough evidence of the outstanding success of the Landsat Programs that it wouldn't take me very long to decide they ought to be continued.

How long do you think it's going to take the National Space Council to come up with some conclusions and recommendations?

Mr. PYKE. At this time we do not have a schedule, sir. What we do have is enough money in hand to keep the satellites alive at least until July, and we expect that the Space Council review will be well underway and hopefully completed by that time.

Mr. SCHEUER. Well, supposing it is completed in June, let us say, and they say—they repeat what most of us would say up here, on a totally bipartisan basis: the Landsat Program is a marvelous program; it sheds credit in our country; it accomplishes a great deal; the cost benefit factor is a spectacular one. And let's say on June 15th they say there is absolutely no question in our minds that Landsat 4 and 5 should be kept alive. What do we do then when the money runs out on July 1st?

You know, we have a process up here. How are you going to integrate what you're doing with our funding process?

Mr. PYKE. I would not presume to tell you what the conclusion will be of the Space Council review before it's completed, but I can assure you that the issues associated with funding of the program

are an integral part of that review, including issues associated with short-term funding.

Mr. SCHEUER. So you're saying that assuming, arguendo, as the lawyers say, that they come up with a positive recommendation—in fact, I can't in my wildest imaginings assume—imagine that they'll do anything different than that, the case is so clear. Let's assume, arguendo, that the lawyers come up with a positive recommendation in June. Are you saying that you're confident that the funding sources are there to keep Landsat 4 and 5 alive until we can get a supplemental, a supplementary appropriation?

Mr. PYKE. Mr. Chairman, I'm sure that the Council will be addressing the funding issues associated with options, with those options that include continuation of the Landsat Program, both short term and long term. As I say, that is an integral part of the study. And should the Council decide that in their opinion the spacecraft should be kept alive for a longer period of time beyond the end of the study, I am sure that the Council's report and recommendations will address the issue of continued funding.

Mr. SCHEUER. I don't know how much further we can beat this into the ground. I don't know whether you're giving—I'm not confident you're giving me an answer that satisfies my concerns, when you say that on June 15th they will address the funding question. I may be too late to address the funding question.

Mr. HENRY. Mr. Chairman.

Mr. SCHEUER. Unless some advance planning has been done to continue Landsat for a number of months after July 1st, while long-term funding is assured, it may be too late, even for your heroic mouth-to-mouth resuscitation efforts.

Mr. Henry.

Mr. HENRY. Thank you for yielding, Mr. Chairman.

Just a couple of questions. You will recall, Mr. Pyke, in our previous discussion that my assessment is there's really no argument as to whether or not Landsat 4 or 5 ought to be kept on, since it's sitting out there and it's earning revenue. The problem, as I understand it, is the EOSAT contract provides for the Government to pay all the cost of operation, but EOSAT keeps all the profit, which is kind of a screwy contract, if you ask me.

Now, the flip side to this is that, on the letting of that contract, as I understand it, assumptions relative to the time frame of Landsat 6 have not all been kept, and so the contractor presumably is arguing with you now, saying well, listen, some of what was implied or understood in Landsat 6 hasn't come on stream; therefore, you know, you're not in a position to bargain. But the fact of the matter is—Mr. Chairman, I say this with great respect because the issue is not keeping Landsat alive; the issue is getting the facts in the open relative to what the operational net profits are of EOSAT, to what extent the public treasury ought to just pour money into EOSAT, to what extent should EOSAT share in operational costs. Perhaps not at all. Perhaps not. But we have not gotten the figures, and Mr. Pyke knows we've been requesting them through the committee. That was now almost a month ago and I just want the record to show that we have not gotten, or I haven't—and I've made the request on two occasions—the data in terms of what the net profits are to the contractor.

[The requested information was subsequently provided by EOSAT.]

Mr. HENRY. So the difficulty of negotiating the numbers, the difficulty that I think Mr. Pyke and the Space Council have in all this is, on the one hand, from any kind of public policy perspective, it's stupid to shut it off; on the other hand, we can't force their hand in such a way that they can't negotiate with the contractor to run away with taxpayer dollars.

I'm going to ask Mr. Pyke if he's in a position to tell us now, or whether any other data has broken loose on your side of these negotiations, as to what the net revenues are to EOSAT after all their operational expenses—presuming they have some internal expenses, although the bulk of the operational expenses are paid directly by the Government. Can you tell us more than you told us in the previous meeting?

Mr. PYKE. Mr. Henry, I recall being asked at the last hearing about the revenues associated with EOSAT, and they do provide that as proprietary information to us.

Mr. SCHEUER. Excuse me. Would you pull the mike closer?

Mr. PYKE. Yes, sir.

They do provide that information as proprietary information to us. I believe at the last hearing the president of EOSAT was asked by the Chairman a question about their bottom line, which is something we're not privy to in the normal course of interacting with EOSAT as a contractor relative to this situation. And there was a response given at that time.

We have, since that time, been negotiating with EOSAT the continuation of Landsat operations, and as of yesterday, when we received the last formal response from EOSAT, EOSAT continues to be unwilling to contribute even a penny of its net earnings toward the operations of Landsats 4 and 5.

Mr. HENRY. If I may continue, Mr. Chairman, I really do think this is an aspect of the issue that has not been well understood. I mean, granted, the figures in a 1.16 trillion dollar budget are not immense, but I can't imagine a Government contract continuing on the kind of basis where you don't have any data made available to the Government, let alone the public, in terms of accountability as to what the return is to the vendor that's operating this on contract to the Government. In that respect, I have to say I realize you're in a difficult position, and I realize it's very difficult to say we're not going to allow it to be turned off if you're getting that kind of stonewall from the contractor.

I have to take on good faith that you share the view of the committee, which I think is overwhelming, and the view of the scientific community, which is overwhelming, that it's foolish to squander the resource by turning it off. On the other hand, I have to recognize that if you say that and you put your feet in concrete and the concrete settles, the contractor has you in such a position that you're not in a position to negotiate on behalf of the taxpayers or the Government of the United States. I think as long as that second element is kept on the table, there remains a very rational discussion. I really feel for you because I realize you're in a very uncomfortable position in this process.

But I want to reiterate that for the record because I've never once seen it spelled out, and I think to a certain extent you're getting beat up unfairly on the issue.

Thank you, Mr. Chairman.

Mr. SCHEUER. Well, Mr. Pyke, can you give us any assurance that the Congressman's questions are going to be met and you're going to provide us that information?

Mr. PYKE. Mr. Chairman, we do not have the detailed business information on the part of EOSAT, which is a private corporation. They are a contractor of the Government's. With regard to this contract, we are provided with information relative to the costs, which we cover with Government funds.

With regard to the contract, they are provided with the data from all of the Landsats, from Landsats 1 all the way through Landsat 6, and the right to sell that data for whatever price the market will bear. They bear the expenses of marketing that data and they are entitled to retain the profits under the provisions of the contract.

Mr. SCHEUER. I yield to Mr. Henry.

Mr. HENRY. I thank the Chairman.

A follow-up question I failed to ask you. Are the terms of the contract such that it is impossible for the Government to recapture operational control of the satellites and once again become the direct vendor and/or to establish a contract with another vendor?

Mr. PYKE. I do not know, sir. That would be tied up in a judgment for our contracting and supporting legal staff to examine relative to the termination provisions of this contract.

A number of provisions of the contract, including the development of Landsat 6, for example, are subject to a normal Government contract termination provision. With regard to the marketing rights for data, one of the items we negotiated last year, in revising the Landsat contract so that it would essentially activate the development of Landsat 6 and provide for EOSAT to receive funds from the Government to pay a portion of those funds back over a period of years to help fund the development of Landsat 6, in the process of that negotiation, we essentially bought back the rights to data from any Landsats beyond Landsat 6. It is not clear how the provisions of the contract with regard to termination apply to the rights to data for any Landsat data from Landsats 4 or 5 or even from Landsat 6, assuming that is flown.

Mr. HENRY. Am I right in presuming from your conversation that the Department is, in fact, reviewing the contract to look at termination provisions, to see whether or not the contract could be relet?

Mr. PYKE. We have reviewed the contract in some detail a number of times, Mr. Henry. We are not at this time looking at that particular—those particular provisions in any special way.

Mr. HENRY. If I'm right, though, in the scenario I'm painting—I think I am, mainly because we're having such difficulty in getting any data—wouldn't that be one club you have in your hand potentially, in terms of saying we don't have to turn it off, we can resume the control, the sale of the data, or contract it to another vendor on a more competitive basis. It seems to me that's a very logical thing for you to be doing. Maybe you're not authorized to

say that you're doing it, but it seems preposterous that you're reviewing the contract without looking at that—

Mr. McCURDY. Would the gentleman yield on that point before—

Mr. HENRY. It's the Chairman's time, but I would be pleased to yield, yes.

Mr. McCURDY. Mr. Chairman, I want to follow up on where the gentleman is going, and before Mr. Pyke answers that question or statement that was just made, I sense that maybe we're going off in the wrong direction here, or we're focusing on something that is not the real issue.

The real issue is whether or not there has been ever provided enough money even to execute these contracts in an appropriate manner. What we're talking about is the funds have been squeezed on both sides so much that whether—you know, we're saying should we get the information from the contractor, are they making profits; if so, should we take all those profits back just to keep this system going. The real issue is that the original authorization was much higher than the ultimate contract amount, and because the contract amount was squeezed to such an extent, they had to devise a really unique contract, at least on the next version, on 6, whereby any profits they make, or basically the company reimburses to the Government out of future funds; is that not correct? I mean, that is a unique type of contract.

Mr. PYKE. Yes. Mr. McCurdy, the contract was a unique type of contract from the very beginning, but including in our negotiations last year, EOSAT willingly signed up to a change to the fixed-price contract, the fixed-price portion of this contract, in which they agreed, in order to cover the total estimated cost at that time of $220 million for Landsat 6, to pay a portion of that back to the Government after we had provided the $220 million, to pay back up to $10.8 million, by paying back up to $2.5 million a year out of net earnings each year beginning with calendar 1988.

Mr. McCURDY. All right. But the point is, the original amounts were anticipated much greater than what we ended up with, in amounts that you had even offered to contract with; is that not correct?

Mr. PYKE. The original contract value was $250 million.

Mr. McCURDY. Right, and you ended up at 220, is that not correct?

Mr. PYKE. Yes, sir.

Mr. McCURDY. So the 30 million became an issue somewhat. I mean, if we had had the original 250 in that contract, we probably wouldn't be as squeezed as much as we are even today; is that not correct?

Mr. PYKE. Yes, Mr. McCurdy. I should point out, though, that the $250 million cost of the original contract, we were obtaining two satellites, Landsat 6 and 7, and a complete new ground system. In the revised contract that EOSAT willingly signed up to last year at $220 million, we obtained one satellite, Landsat 6, and its instruments, and a somewhat limited ground station.

Mr. McCURDY. Right. When you say willingly signed up to, I mean it was a lengthy and difficult negotiation, was it not?

Mr. PYKE. Yes, sir.

Mr. McCURDY. And they didn't have a lot of options, to either take that amount or not?

Mr. PYKE. They certainly could have backed away at that time.

Mr. McCURDY. Well, after considerable investment. But where would we have been? Was there anyone else knocking down the door, beating down the door, to get into this contract at that level?

Mr. PYKE. No, sir, but we did not in any way force them to sign that contract. In fact, they were somewhat enthusiastic—

Mr. McCURDY. I understand, but—

Mr. PYKE. —and we reached agreement at that time.

Mr. McCURDY. But part of that consideration, was it not, the fact that they had a revenue stream from 4 and 5? Was that not something that was considered?

Mr. PYKE. Last April 1, when that modification was signed by both the Government and EOSAT, there was no funds on the table to cover the operation of Landsats 4 and 5 beyond September 30 of last year, none proposed by the administration and no discussion I'm aware of of possible additional funding added on by the Congress, as was done to cover the first six months of this fiscal year.

The question of longevity of Landsats 4 and 5 has been an outstanding issue for a long time. Landsat 5 was launched because Landsat 4 had been partially disabled, even before the first contract with EOSAT was signed. So the issue of the lifetime of Landsats 4 and 5 and the uncertainty about the extent of the bonus period, which EOSAT has had essentially to take advantage of with regard to receiving additional revenues, has been in that status for some time now.

Mr. McCURDY. The original—We went through a cycle there when we're talking about 6 and 7, the next generation of Landsat. And one of those versions that they discussed was Omnistar. Wasn't that the name—not Omnistar. It's going to be a station or a platform that could have been reconfigured in time. You could take the shuttle up there and you could replace instruments or upgrade them. Was that not correct?

Mr. PYKE. Yes. Mr. McCurdy, after the original contract with EOSAT was signed, EOSAT came to the Government and said we've got a better idea. We would like unilaterally to propose that we change the design of the spacecraft and that we build a platform, which they called Omnistar, which they believed had more potential in the future. And after a detailed review, the Government permitted them to go with the design they proposed at that time.

Mr. McCURDY. Right. And had the Challenger incident not occurred, then we probably would have been in a totally different contract environment than we are today?

Mr. PYKE. Yes, sir. That design required not only a launch on the shuttle out of Vandenberg, which, of course, is no longer available, but servicing of the anticipated long lifetime Omnistar platform.

Mr. McCURDY. So here we are as a government again, due to problems in another agency—you know, we're all squeezed. OMB is putting the squeeze on you all. You've got tight contract funds, and we didn't anticipate that 4 and 5 would go on, and therefore we again are trying to pick each other's pockets; is that not correct?

I know you can put that in bureaucratese, but I wanted to put that out in common language here.

Mr. HENRY. May I just—Would the gentleman yield to the chair?

Mr. MCCURDY. I'm sure that Mr. Pyke would love for me to yield at this point, because I'm not sure he can answer that question.

Mr. SCHEUER. I think the Chairman would like to regain his time.

I would be happy to yield to the gentleman, Congressman Paul Henry.

Mr. HENRY. Thank you.

I'm not trying to get the gentleman off the hook because I believe my colleague from Oklahoma has done a good job of pointing out the other side of the story, and that is true. The question is, when we try to figure out who's picking whose pocket, one set of books are public and they are known. The other set of books aren't and they aren't. An that's the issue. So it's pretty hard to make the determination whether that kind of pick-pocketing is occurring at all. That's my only point.

I thank the Chair.

Mr. MCCURDY. But there are also about five agencies that are having their pockets perused right now at the same time.

Mr. SCHEUER. Okay. Now, we've had questioning by Paul Henry, we've had questioning by Dave McCurdy. We will now yield to the ranking—

Ms. SCHNEIDER. Thank you, Mr. Chairman. I'm going to choose to shift gears for a moment and talk about global change. I'm wondering if you have a long-range research plan that you have devised in order to guide some of our policy decisions here.

Dr. EVANS. Congresswoman Schneider, we have asked for an increase of, as you know, of $11 million on the Global Change Program. On that, long-term observations are going to account for $3.5 million; operational ocean monitoring, global sea levels, networks for detecting stratospheric changes, in cooperation with NASA, research on physical and biochemical climate processes will be $2.5 million. Climate diagnostic and prediction efforts of $2 million; acquire and maintain and distribute a long-term database and related climate information, I can ask Dr. Thomas to expand on each one of those if you would so wish.

Ms. SCHNEIDER. Certainly, yes. Dr. Thomas.

Dr. THOMAS. Thank you.

There is in process now, within the Federal Government, in the intergency working group, a development of a research plan for the Federal agencies for the national program. And we have been actively involved in that through a number of our scientists, in particular Dr. Albritton, who is with our laboratory in Boulder. That plan will be out shortly. It's in sort of a draft stage now or—

Ms. SCHNEIDER. That's what I'm most interested in. What do you mean by shortly?

Dr. THOMAS. Well, I would think in this several months, within the next couple of months. I don't have a date right now.

Ms. SCHNEIDER. Okay.

Dr. THOMAS. But it is in draft and people are—the scientists are reviewing it. In fact, they're working on it early this week, also. So

that will be out to reflect a somewhat more in-depth view of the global change issue from a Federal standpoint.

In addition to that, we in NOAA will be developing long-range plans for the various elements. Dr. Evans has mentioned the broad program elements. But we will have our own planning geared to, for example, global sea level, some of the research thrust, the relatively important trace species, greenhouse gas work that we're doing—

Ms. SCHNEIDER. Will these be—These will be more than a one-year plan, though? There'll be a five year, a ten year—

Dr. THOMAS. That's true. Yes, they would be mutliyear plans, that's correct.

Ms. SCHNEIDER. Multiyear, more or less. Give me—

Dr. THOMAS. Say five. Five is a good—three to five years. In some of the components, we have had on the table for a number of years plans in quite a lot of depth. For example, on the greenhouse gas issue, and particularly those species that are, besides carbon dioxide and how we intend to upgrade our monitoring and our research into both the processes that take place as well as the modeling of the chemistry that's involved.

Ms. SCHNEIDER. I would really appreciate it if, as soon as that draft is available to be made public, that you share that information at least with me, because there are pieces of the global warming legislation that I've introduced, with many, many other Members, that we're anxious to make sure that the policy proposals that we are making will reflect the kind of research direction that at least your research plan has outlined.

Dr. THOMAS. We will do that.

Ms. SCHNEIDER. Okay. Thank you.

Another question I had, quickly, on the National Weather Service proposals. A few months ago, when Commerce was considering closing down about 100 of these weather stations, the reason that was given was some of the budget shortfalls. I wonder if you can share with us about how much money could have been saved by shutting down the weather stations if this proposal had been followed through?

Dr. EVANS. Thank you. Bill, do you want to field that one?

Dr. FRIDAY. Yes. Thank you very much.

The original proposal for the FY '90 budget included the closures of approximately 70 weather stations in order to save, in that particular budget, $14.8 million. Those weather stations were essentially those that had a lesser priority. Certainly it was not a decision of the fact that these weather stations were not performing a very useful function and serving a useful purpose. But in balancing out the priorities in the Weather Service for the modernization, for the increased replacement of existing components of the Service that are approaching the end of their useful life, it was simply a balancing act of what was the highest priority within the organization.

Ms. SCHNEIDER. Is the administration planning on covering that shortfall? How are you planning on covering it?

Dr. FRIDAY. The administration has proposed, and the documentation is currently in the hands of the Appropriations Committees, reprogramming for the fiscal year 1989 shortfall to eliminate the

closing of any weather stations in 1989. My understanding is, although it has not yet arrived, there will be a budget amendment or a reprogramming associated with the FY 1990 budget submission that will soon be arriving.

And the next question you're going to ask me is how soon is soon, and I simply don't know.

Ms. SCHNEIDER. Well, two things come to mind. Why will you give it to the Appropriations Committee instead of to this committee—I'll let you answer that one first.

Dr. FRIDAY. Okay. The reprogramming, I'm told by—I'm told the reprogramming is required by the rules to go to the Appropriations Committee. The budget amendment will be coming to Congress. It will not be going to the Appropriations Committee only. It will be going to all of Congress. So it will come to this committee.

Ms. SCHNEIDER. And the modernization moneys?

Dr. FRIDAY. The modernization moneys, various modernization components, are included in the '90 budget, including the next generation weather radar, the automated surface observing system, moneys to continue the AWIPS program, the Advanced Weather Interactive Processing System, and moneys for the Class VII computer capability at the National Meteorological Center. Those will continue to be—there's no modification of those general levels. Those programs are essential to the modernization. Congressman Valentine is well aware of the status of some of our equipment in the field. He held a hearing recently in his own district describing a failure of the Weather Service system in North Carolina because of the age of the equipment. And the next generation weather radar is absolutely essential to replace that aging equipment.

Ms. SCHNEIDER. Well, I am aware that there were a couple of full-time stations at various airports that were slated for closure, and that does concern me when we are talking about shifting priorities, particularly at airports, when we recognize that there are so many weather-related incidents at airports.

Dr. FRIDAY. That is one of the considerations that the Secretary used in his determination that we would not continue to close weather stations in the fiscal year 1989 and 1990 budget and that we would ensure that no weather stations were closed until the service had been modernized so that we could assure Congress, as required by legislation passed last year, that there will be no degradation in services prior to the closing of one of those facilities.

Ms. SCHNEIDER. One of the things that came to my attention is that a number of the different tests for modernization have been scheduled for central U.S. and the West, to the exclusion of the East. Now is that to imply that we don't have anything to worry about in terms of weather patterns in the East?

Dr. FRIDAY. When we move GOES-West to the East to cover the hurricanes, we get accused of having an eastern mentality. When we test in the middle of the country, we are accused of having an Oklahoma mentality.

What we are testing in the central part of the country in a five-State area—Kansas, Oklahoma, Colorado, some parts of Nebraska, and some parts of Missouri—is the first integrated activity of all of the new technology and the new office structure that is proposed in the strategic plan. This modernization demonstration program that

we have is designed to test to ensure, first of all to us, that all of these technologies work together and that we can, indeed, deliver the warnings and services with the restructured Weather Service. They are, furthermore, designed to deliver to you the necessary information to convince you that that is working.

That is not the only test that will be required. The next generation weather radar schedule, for example, the first operational radar, goes into Oklahoma City, because that is where we have had a lot of experience and we are sure we can bring that up very rapidly. The second one goes into Melbourne, Florida. One of the reasons is to support the shuttle operations at the Cape, but the second reason, and perhaps in the long term as important as the shuttle operations, is to ensure that we have experience in coastal environment, we have experience in the marine environment, and in a different section of the country other than the middle of the Nation.

The middle part of the country is chosen because it has, with the exception of the marine weather, it has virtually every type of weather known; it has the severe winter storms, it has the severe spring storms, it has flash flooding, it has river flooding.

Ms. SCHNEIDER. Just about everything but coastal storms.

Dr. FRIDAY. Everything but coastal storms; that's correct.

But the law, Public Law 100-685, requires us to certify—the Secretary of Commerce to certify—that before we do any changing in any region, that we have clearly demonstrated that we will not be degrading the services in that region. So there will be evaluations as we move into other sections; there will be evaluations of the marine capabilities of the system at Melbourne, et cetera.

Ms. SCHNEIDER. So that our primary reliance in the coastal regions of the United States, particularly the east coast, will be on your Florida test site.

Dr. FRIDAY. That would be the beginning.

Ms. SCHNEIDER. That would be the beginning.

Dr. FRIDAY. But not the primary.

Ms. SCHNEIDER. All right.

But if we are to anticipate any storms coming from the Canadian area, how are we going to monitor those?

Dr. FRIDAY. In essence, what you will have is that each site that is installed—for example, whether it be the Washington office here—will undergo a complete testing and undergo a complete validation before any changes are made in the surrounding area.

Ms. SCHNEIDER. When will those tests be completed?

Dr. FRIDAY. It depends on the site and depends on the equipment delivery at that site. Preparations for the test will begin within about six to nine months prior to the actual equipment delivery dates, and the test will be completed probably six to nine months after the last delivery—equipment delivery date, so that each site has a different series of tests.

We are required by Public Law 100-685 to provide to Congress each year a detailed transition plan on the next two years of activities. The first one of those plans will be delivered in October of this year, and we are in the process of outlining in a great deal of detail what tests will be accomplished, where they will be accomplished, and what offices will be involved in the next two years' worth of

activities. Each year, that will be updated, so that each year we will provide this committee and other interested committees with the necessary information for oversight and assurance that we are living up to our commitment to assure a quality weather service for this country.

Ms. SCHNEIDER. Thank you very much.

Yes, Mr. Burton.

Mr. BURTON. Thank you, Ms. Schneider.

Perhaps just a word of clarification. In the last Congress, when I and others with NOAA worked with the chairman and his staff in developing the public law which Mr. Friday is referring to, there was a lot of consideration and a lot of concern for the sorts of issues you are raising. It is not an easy thing to entirely overhaul the weather system to the tune of restructuring it and shutting down well over 100 stations, and so, in addition to the testing program that we have been talking about which will focus on mid-America, we realized that it was going to be important to put in the provision that has been referred to, which essentially says nothing will be changed in any current and existing weather office until it is aptly demonstrated and then certified by the Secretary that services had not diminished.

So, again, in the case of your backyard or any other Member's Weather Service office, until it is certified that nothing has changed, no services have been degraded, that office will stand, and so, in essence, we have individual tests going on at each site, and once that new NEXRAD, AWIPS, and ASOS is in place, and it is certified that it is working absolutely correctly before the Weather Office is changed and shut down.

Ms. SCHNEIDER. What kind of criteria do you use to make that certification?

Mr. BURTON. I will defer back again to Dr. Friday.

Dr. FRIDAY. Thank you very much, Kent.

That's a very good question, and it's one that we're addressing at present time. We clearly have to have an objective, independent test of the performance of the new systems. That's a commitment that we have to you that we will, indeed, do that. It will not be evaluated by me or my staff; it will be evaluated by an outside actor. Now I don't know who that outside actor will be yet. We're in the process of preparing the detailed plans that will be coming forward in this first of the detailed transition documents.

In order to ensure that we have provided quality service to the Nation, we will continue, for example, to do as we are doing now. Some people challenge us on the accuracy of our forecasts, but we know what those are; we verify every forecast issued by the National Weather Service and every warning issued by the National Weather Service now. We will continue to do that, so that clear, objective data will show whether or not there has been an increase or a decrease in the accuracy of our warnings and forecasts as we move. That will show that.

But service is more than just simply the accuracy of a warning, service is the interaction—

Mr. SCHEUER. Pull the mike a little closer, please.

Dr. FRIDAY. I'm sorry, sir.

Service is more than just simply the accuracy or the numbers that describe how accurate a temperature or a precipitation forecast is. Service is making sure that that weather information gets to the public that needs to be served, making sure that it gets to the local civil defense officials that need to be served, and the aviation community, as you have indicated, a very major activity, to ensure that the aviation information is flowing adequately and accurately.

So all of these phases must be evaluated by this team that will be doing the evaluation and certification. That's a major task that we have ahead of us, and that is, indeed, one of the things that we'll be presenting, is the methodology for doing this in the next version of the plan that will be available for your review this fall.

Ms. SCHNEIDER. Great. Well, I thank you, and I think that I would have a little more confidence if you were to say that this review would be completed by not an outside actor but, rather, by outside scientists or meteorologists. Granted, we are talking about information transfer, and actors are very good at communications, but you had better believe that the Science and Technology Committee members are interested in the science.

Mr. SCHEUER If the lady will yield, is she saying that we have had enough actors in Government for a while?

Ms. SCHNEIDER. Mr. Chairman, you wouldn't think of putting me on the spot now, would you?

I thank you very much, Dr. Friday.

Dr. FRIDAY. I would like to amend my statement to indicate that I did intend a scientific and technical assessment.

Ms. SCHNEIDER. Terrific. Thank you very kindly.

Mr. SCHEUER. I'm going to continue yielding to Members for questions, but I can't help interrupting for just a very brief comment, first to say that Congressman Tim Valentine did conduct a first-class hearing in North Carolina with Congressman David Price. They conducted that jointly, and I had the honor and privilege of being present at that hearing, and I very well remember a sense of urgency coming from the National Weather Service at that hearing that, frankly, I haven't felt today.

We talk about repair and rehabilitation and modernization, yes, but when, and how fast, and when will it be completed? because if we stretch it out far enough, by the time we finish over an extended period of time modernization, we will have to start a whole new round of modernization, because what we plan today and not have finished several years from now will already be obsolete and totally inadequate to the needs of the twenty-first century, which we are approaching very fast.

Let me read you part of the record. This is from the National Disaster Survey Report of the performance of the National Weather Service during the November 1988 tornadoes in North Carolina. Quote: "Overriding all is a compelling, almost desperate need to upgrade and replace the Nation's aged system of weather radar." A desperate need.

Now that is not congressional rhetoric, that's your own National Weather Service testifying down there, and, frankly, I would like to know not only how much, where is this $25 million going to come from, but when, and when are we going to start, and when

are we going to complete that rehabilitation and modernization of a desperately needful, grossly undermanned and outgunned National Weather Service, undermanned and outgunned by the elements, relying on obsolete, obsolescent, aging, and totally inadequate equipment that is more relevant to a Third World country than it is to the United States? How much? When will it be started? When will it be completed?

Dr. FRIDAY. That's an extremely pertinent question, sir, and I certainly—if I have not indicated my urgency in my comments today, then I apologize for that, because we are moving forward—

Mr. SCHEUER. Well, look. You don't need to waste time with apologies. We respect your bona fides. But we want to know how much, when it is going to get started, when it is going to be completed, because you can thin out, and delay, and put this in the holding pattern and what-not, and we people up here then are trying to punch our way out of a bag of wet Kleenex. We want to have specific answers.

You have got an enormous, awesome job of rehabilitation, modernization, and renovation. It is shameful that we have let our National Weather Service fall into a state of such awful, shameful disrepair. How much is it going to cost to do it? When are you going to start the job? When are you going to finish the job? Those are our questions. All of us want to know.

Dr. FRIDAY. With respect to the components of modernization—and unfortunately I have to speak with components now, and I'll speak of the entire thing in just a moment. With respect to the components, the first and foremost and the one that was referred to in Mr. Valentine's hearing was the next generation of weather radar, that replacement. The first operational radar will be installed in January of next year, and it will be installed in the Oklahoma City operational area. The final prototype development and testing is being conducted at present time.

The second one that I mentioned at Melbourne, Florida, will be going in in March of next year. The third one, in the Washington, D.C., area, will be going in in June of next year, and from that time period we will begin installing these radars then at the rate of once a month, and by the time 1991—late 1991—comes along, we are going to be installing these radars at the rate of one a week.

Mr. SCHEUER. Well, I mean, you have got about 160 of these things to install.

Dr. FRIDAY. Yes, sir, I know.

Mr. SCHEUER. I am going to have to yield to my colleagues. They are all eager to ask questions. I'll come back to this when I'm finished. But when I say, "How much? when does it start? when is it over?" I'm talking about 168 I think it is—around 160 of these, and it doesn't seem to me that it would be so difficult to do them simultaneously. You have got 160-odd installations that are grossly obsolescent. Why do you have to do them seriatim, one after the other? Why can't you just put out the orders and do them all in a discrete time frame which is very short?

Congressman David Skaggs—with my apologies, David.

Mr. SKAGGS. Well, I don't want to start questioning until I hear the answer to that question. So I appreciate the chairman's indulgence, but Dr. Friday?

Dr. FRIDAY. I'm going to have enough trouble trying to install one a week around the country. I appreciate the fact that it would be much better if we could install them one—you know, more simultaneously than that, but the fact of the matter is, there are economic rates of production; these are major pieces of equipment. As near as we can tell, we have tried to adapt to the most economic rate of production of the next generation of weather radar, and that approximately is one a work week. There may be some possibilities for accelerating that schedule, but—

Mr. SCHEUER. You are talking about over three years, and these suppliers—we were intimately involved in all that—they are major American corporations. These are not "mom and pop" stores. One of them is just a few miles from my district. These guys, these are mega-producers. They are the people that man the American war machine in nothing flat. Are you telling me that they can't produce more than one a week of these? I can't believe that.

Dr. FRIDAY. I can certainly provide you information with respect to their capabilities for the record, sir. I simply do not have that information.

Mr. SCHEUER. Well, look. We're talking about Unisys. This is not a "mom and pop" store. Why don't you find out from Unisys whether they could complete the 160 of them in a year's time instead of three and a half years' time, or six months' time? I hardly could believe that it would be beyond their capability to mass produce these things if they got the order and they knew that the checks were coming in.

You will have to forgive my cynicism, but I would admit to having a feeling that this is more a question of funding stretch-out than manufacturing stretch-out. Maybe you can enlighten me on that after checking with Unisys and the other suppliers.

Dr. FRIDAY. I will check on that, sir, and get back to you.

[The requested information follows:]

The existing contract schedule for deployment of the 165 full-scale production NEXRAD radar units at the rate of four a month was established to: (1) ensure sufficient time and funding for Government preparations to transition the sophisticated new radar systems into field operations; (2) minimize the gap between deliveries of the last limited production and first full-scale production units in order to maintain production efficiencies; and (3) achieve and sustain maximum production efficiencies.

The following constraints preclude acceleration of the NEXRAD deployment schedule:

The Government has contractual commitments to provide Unisys with access to radar and communications sites 21 months prior to the date of equipment delivery. In order to meet this requirement and ensure readiness of the user facilities for delivery of equipment, real property acquisition and planning must begin about 44 months prior to equipment delivery at each scheduled site. The Government has established an optimum schedule in terms of: (1) coordinating, acquiring, and constructing NEXRAD facilities; (2) affordable annual funding increments; and (3) training the workforce to take advantage of the new operational equipment.

The fixed pricing contained in the limited production contract and full-scale production option with Unisys is based on an economic order buy of a large quantity over a period of time designed to maximize production efficiencies. The Government is committed to contractually specified incremental funding on an annual basis to fund production costs for the contractual schedule of deliveries. Acceleration of scheduled deliveries would require renegotiation of payment schedules and acceleration of funding requirements on an annual basis.

Unisys would require about a year and a half contractual notification and acceleration of over $50 million, in FY 1989 and 1990 alone, to ramp NEXRAD unit deliveries up to five per month beginning late in FY 1991. This would require acceleration of scheduled preparation of NEXRAD user facilities requiring from two to three and a half years lead time. An accelerated facilities schedule would require FY 1990 acceleration of over $60 million in facilities efforts planned for FY 1991 and 1992 and could place the Government in the high risk situation of not having facilities ready for contractor access in accordance with contract schedules. Another critical limitation in accelerating the schedule for implementation of NEXRAD is the inability to expedite training of the work force to effectively use the new NEXRAD systems.

Early in the limited production phase, the Government accelerated delivery of the full-scale production units, shortening it by four months from the dates originally established for each NEXRAD unit in the contract. This accelerated schedule has already accomplished a finely tuned balance between the maximum production rate for the NEXRAD equipment and the interdependent Government site acquisition/construction process. This schedule is based on a maximum effort being expended within the resources available from both Unisys and the Government.

Mr. SCHEUER. Okay. With my apologies.

Mr. SKAGGS. No, no. Thank you, Mr. Chairman.

I would like to inquire a little bit about international cooperation in collection of data for purposes of our own domestic forecasting. I don't know which of you gentlemen would be most informed about that sort of thing. As I understand it, particularly in looking at mid- and longer-range forecasting, obviously, the data we get from sources outside our own domestic sensors is critical, and yet an awful lot of data is literally lost in transmission because of Third World data link degradations. What are we doing in terms of international cooperation and devotion of our resources to international weather data collection efforts that could really enhance our domestic capabilities?

Dr. FRIDAY. Sir, you have hit on a very critical point as far as the weather forecasting ability beyond the immediate one- to three-day time frame, and that is the availability of data around the world. We have two approaches to that. One, we try to do it ourselves with our own polar orbiting satellites to expand the amount of data we have, and the polar orbiters become very critical input to our numerical models that we run at the National Meteorological Center. But the area that you hit upon is still a very fundamental data source and one which we need to concentrate on.

The World Meteorological Organization, which is a specialized agency of the United Nations, is the agency that is charged with the overall responsibility of coordinating international weather information, exchange of information, and cooperation across the borders.

As you are well aware, the weather knows no national boundaries, and it is important for us to know what goes on in Canada and Mexico because that affects us immediately, but recent studies have shown that the ability to know what goes on on the opposite sides of the world might affect the accuracy of a five-day forecast. So we are required to pretty well know everything that is going on.

The World Meteorological Organization has several programs under way at present time as a part of the World Weather Watch, which is the overall program to observe the weather around the world, to try to help out in those sections of the country—those sections of the world where there is a limitation in the ability of those nations to observe and communicate weather data.

We are doing part of that through a State Department program in cooperation with NOAA National Weather Service called the Voluntary Cooperation Program, in which some resources from State Department assistance programs are channeled into meteorological infrastructure for these countries. They may be in observing systems, they may be in communications systems, they may be in small message switching computers that allow interface with the global telecommunications network of the WMO.

Indeed, that is a major effort. It is a coordinated effort with many different nations working toward that. The primary problem areas in the world at present time are Africa and South America, and we have major programs going in both of those continents to try to improve the data flow.

Mr. SKAGGS. Is the bureaucracy of the World Meteorological Organization itself a problem in getting a more effective job done there?

Dr. FRIDAY. No, sir, I honestly do not believe that. I'm the United States permanent representative to the WMO, and the WMO, of all of the various U.N. agencies, has a reputation of being a particularly effective agency for actually accomplishing that.

The WMO staff, the bureaucracy, is only 200 people. Most of the work is actually done by cooperating member countries in working in these various areas.

Mr. SKAGGS. Perhaps I was being more delicate. In terms of really forcing the issue with member state organizations.

Dr. FRIDAY. It is difficult for any international body, any body of that nature, to force anything with any sovereign state. There is always that problem. The fact is that all of these nations likewise need the information from their neighbors, and, as a result of that, the program in Africa, for example, is very broadly supported by a large number of nations both in Europe and North America, for example, and Asia, and we have cooperation across most of those countries in Africa to pull together a better communications network. I'm fairly excited about the possibilities of that.

Mr. SKAGGS. Well, I would think reciprocity would be the currency that makes things happen there.

Looking also at the reciprocity issue on a commercial level, again, I confess to being only semi-informed about this, but the potential of data collection through commercial aviation, particularly in the next generation of avionics which will enable real time data transmission from commercial planes, the potential that exists in a similar way, it would seem to me, if we could figure out two-way data links via, say, navigation satellites in return for data transmission from ships at sea of weather data hold an awful lot of promise, especially in getting oceanic weather data. What are you doing in those areas?

Dr. FRIDAY. In both of those areas, we are working to expand our collection. We are working through the WMO and through the IOC—the Intergovernmental Oceanographic Commission—to expand data collection on ocean vessels through commercial communications satellites—INMARSAT—as being the primary means of doing that at present time.

We are working to expand our rate of collection there, and we're working with other nations to share the funding of those. When you are dealing with an international consortium that basically provides communications at a cost, you have to be prepared to pay the cost of those communications when the observations come in, and we have entered into agreements with other countries to do just that as a part of our basic data collection.

Mr. SKAGGS. You say you are working on improving. Give me your best success story at this point.

Dr. FRIDAY. The number of ocean observations over the past two to three years have improved by, I don't know exactly the number, I think it's somewhere on the order of around 15 to 20 percent as far as the number of ocean observations coming in. Quality control of those ocean observations is improving as well. I'll check and verify that number for you for the record.

But we're working at present time in the United States with the aircraft industry to use the navigation data that you mentioned, the ACARS system. When we actually take and plot the information availability over the United States and its adjacent waters of navigation-based environmental information, we have a substantial improvement in the amount of information that we could obtain, particularly from the coastal marine areas. We're working toward that now, we're working with both the aviation aircraft companies as well as the FAA to ensure that we can have that data flowing in real time.

Mr. SKAGGS. I'd appreciate it if you could expand for the record on exactly what's going on there in as much concrete detail as you can muster.

[The requested information was not provided.]

Mr. SKAGGS. I guess the next question leading on from that is, with that kind of a potential increase in available data, what does that do in driving your computer needs, and how are you meeting those computer needs?

Mr. FRIDAY. The global prediction process is one that requires the best specification of the atmosphere that you can produce and the best representation of that atmosphere in terms of the mathematical equations that are used to describe the processes. That requires a substantial computer power. We have at present time at the National Meteorological Center a six-generation, or class 6, computer which has served us very well over the past three or four years since we've had it installed and operational.

The ability to forecast in the research community has gone considerably beyond what we are currently able to apply operationally. We have in the President's budget for 1900 a request to upgrade that computer capability at the National Meteorological Center to a next generation machine to go from a machine that has a computational power on the order of 100 million floating point instructions per second up to a computer power on the order of 10 billion floating point instructions per second.

So that capability then will, indeed, permit us to start taking into consideration more of these data that come in from the polar orbiting satellites, from the ground-based systems that we are trying to improve, from the various data sources over the ocean that represent the very critical air-ocean interface for us. That capability should be on line--if the budget is approved as requested, that capability should be on line in 1991, and we should start to see the same sort of an improvement in the aviation forecast, in the weather forecast, that we have seen as we went from the older computer systems to the class 6 computers three and a half years ago.

Mr. SKAGGS. If I could ask one other question for the record, Mr. Chairman.

I had occasion last November to spend a day at the European Center for Mid-Range Forecasting, was quite impressed with their operations. In a most superficial sense, there appeared to be a high level of efficiency in what they are able to do with a relatively modest staff.

I'm wondering whether or not you have—I'm sure you have close collegial relations with those folks, but I'm wondering if you have looked to their organizational model, their staffing patterns, and whether or not there is anything to be learned in terms of meeting our own needs perhaps in a more personnel efficient manner.

Again, this is a—I won't characterize my own question. I would appreciate it, to the extent that you have examined that to see whether we can learn anything from the way they do business that would help us do ours in a more cost-effective basis; if you haven't done that, what your plans might be for doing that. I don't want to take any more time this morning, but if we could have that provided for the record.

Mr. FRIDAY. I would like to make one comment on that, and I will provide that for the record for you. The major reason for a very efficient, effective organization there is the fact that there are very few customers. In other words, we support hundreds of different customers out of our center. Each one of those customers have demands; each one of those customers have products and services that go out.

The European Center for Medium Range Forecast is the finest example of applied research in the world of meteorology. They have a very narrow focus on doing nothing but doing the best job of numerical weather prediction that can possibly be done, and that's what they do. They go out, and they pay. It's very difficult to be the director of the British Met. Service located a few miles from here when any of his people can walk across, get a job at the European Center at a substantially larger increase in pay.

Mr. SKAGGS. Well, perhaps you can elaborate on those factors as well in your response for the record.

Thank you, Mr. Chairman.

Mr. SCHEUER. Congressman Sid Morrison.

Mr. MORRISON. Thank you, Mr. Chairman.

Let me shift the discussion, which has been most informative, back to the concerns, I suppose, that many of us bring. Certainly Members of Congress have since 1981 enthusiastically expressed their concerns about our own local weather stations.

I have a particular concern as it relates to the West, and we have joined the others, of course, in keeping the pressure on not to close stations. But I notice that, for instance, in 1981 the full-time employees in the Western Region was 900; by 1984, it was down to 703; by 1989, it is reduced to 581; and of the 581 positions, 69 are currently vacant. So we have really, without closing stations, we've trimmed back by 35 percent or more on the actual people that are there to do the job, and the programs remain, as Congress has dictated, but staffing has been reduced rather dramatically; and when I visit these stations locally, they are so demoralized that I sometimes wonder if they are still able to function.

So I just want some comments along these lines. I realize you are trying to make dynamic changes, and I have listened to you say that we haven't reduced service as a result of this, but yes, you have, whether you have really intended to or not.

Dr. FRIDAY. Certainly I recognize the situation in the field and, as a matter of fact, in the headquarters as far as staffing changes have occurred. We've had a significant reduction in staffing of the

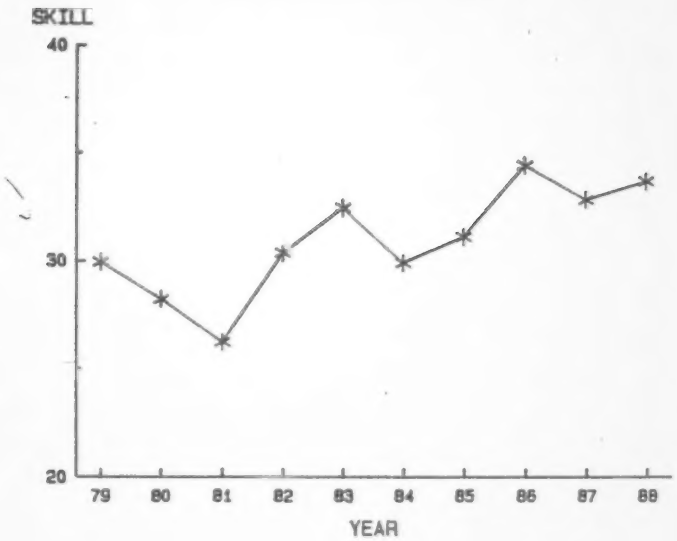
National Weather Service over the past eight or nine years. That's basically budget driven; there's no question about that. Some of those are efficiencies driven; we've made changes in the organization that have permitted us to do things, we think, a little smarter.

The bottom line on the forecasting capability of the field, across the board, is the fact that the forecasting ability, the quality of every forecast and warning issued across the country continues to improve or hold its own. So the objective measure of the accuracy of our products and our services over the past several years—and I can provide that for you for the record; I don't have it here, but I can provide that for you for the record—do show the fact that, even with these reductions in staff, we have not reduced the accuracy or the quality of our product.

[The requested information follows:]

NWS PERFORMANCE ON FORECASTS AND WARNINGS FOR THE PAST DECADE

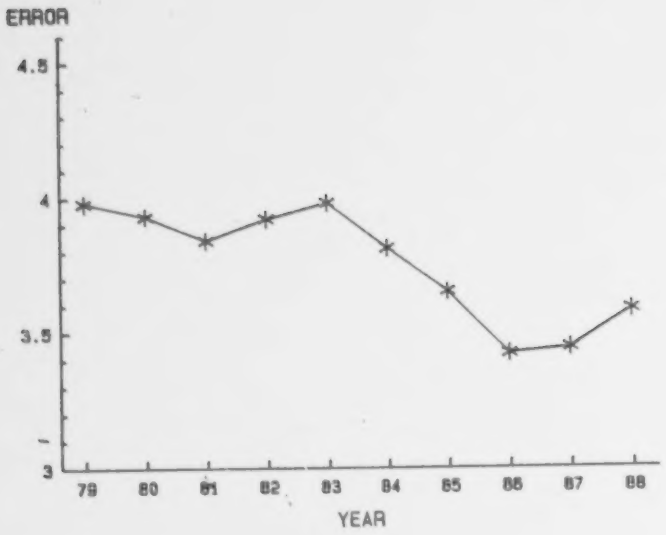
PRECIPITATION FORECASTS



This graph shows the skill of NWS precipitation forecasts over the past decade. The skill is measured as a percent improvement over a fixed standard, which in this case is the long-term frequency of precipitation. The scores are for probability of precipitation forecasts issued by Weather Service Forecast Offices (WSFO's) for periods of 1 to 2 days. For a perfect forecast the skill score would be 100. The results presented here are based on data averaged over 1-year periods for all WSFO's in the contiguous United States. Fluctuations in the scores from year to year are normal and are related to climatological variations. The overall trend in skill for the past decade is up.

NWS PERFORMANCE ON FORECASTS AND WARNINGS FOR THE PAST DECADE

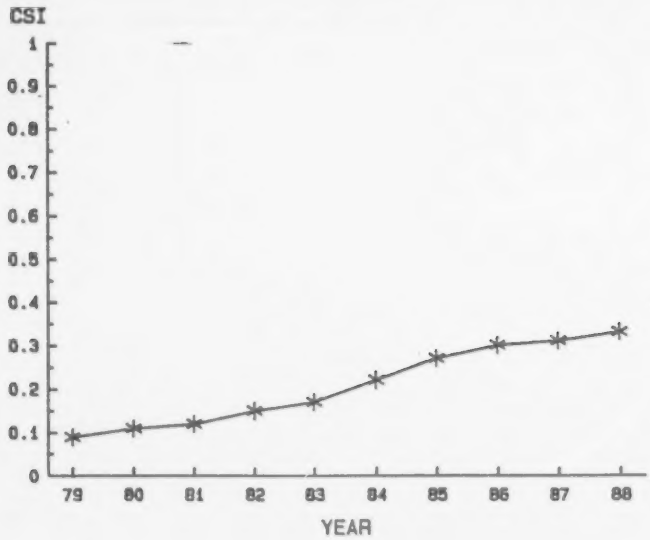
TEMPERATURE FORECASTS



This graph shows the absolute temperature error in degrees Fahrenheit. The data are for forecasts of maximum and minimum temperature issued by Weather Service Forecast Offices (WSFO's) for periods of 1 to 2 days. The results presented here are based on data averaged over 1-year periods for all WSFO's in the contiguous United States. Fluctuations in the scores from year to year are normal and are related to climatological variations. The overall trend for the past decade has been a reduction in magnitude of the temperature error.

NWS PERFORMANCE ON FORECASTS AND WARNINGS FOR THE PAST DECADE

SEVERE THUNDERSTORM AND TORNADO WARNINGS



This graph shows the Critical Success Index (CSI) for severe thunderstorm and tornado warnings issued by Weather Service Forecast Offices (WSFO's) during the past decade. The CSI is a measure that give credit for severe weather events that are covered by warnings and assesses a penalty for severe weather warnings for which no events occurred. The index ranges from 0 to 1. The results presented here are based on data averaged over 1-year periods for all WSFO's in the contiguous United States. Despite the steady increase during the last decade the CSI remains at a relatively low level.

Dr. FRIDAY. We have reduced the presence in some cases; there's no question about that. We have reduced the ability to do some of the very specialized and personalized activities that we have done in some cases; there's no doubt about that, and that is, indeed, perceived as a loss of service.

Our fundamental mission, however, of producing weather warnings and forecasts, in general—and I know enough to say in general because there are always counter examples, but, in general, remains fairly good. It certainly needs the modernization that Mr. Scheuer mentioned. It certainly needs the move forward to replace the systems that—and Mr. Scheuer characterized them very well—are, in many cases, deplorable, and that's what we're trying to do with the budget proposal that we have forwarded.

Mr. MORRISON. Well, we look forward to the modernization. I'm concerned about this as a basic function of Government, and I think we probably—at least in my experience, we are probably pushing very, very hard again for the accessibility of the information. I don't care how accurate your forecasts are—yes, I do care, but I want to make sure that people are able to access them to the point that the Weather Service remains a service rather than just a forecast, something for the record that sits here and gets dusty in Washington, D.C.

Well, I know that you are probably frustrated, too, because since these are budget driven, it means that someone else is telling you, in essence, what we are going to do with your request, and to the extent that some of us could help you in some backlash against our good friends at OMB, please let us know so that we can be part of the forecasting team as well.

Thank you, Mr. Chairman. I appreciate the chance to make this input.

Mr. SCHEUER. Thank you, Congressman.

Congressman Chris Shays, please take such time as you may need.

Mr. SHAYS. Thank you, Mr. Chairman.

If 50 percent of our budget is entitlements, they come in, they come out; 15 percent are interest payments; at least 35 percent to do all the goods and services as Congressman Morrison mentioned, basically—and then you take 28 percent, which is defense; at least 7 percent, in which we try to run the judicial branch, and the legislative branch; and what we have left over for the executive branch, we take it out of that tiny 7 percent. And I'm just struck by the hearings that I've attended that in some cases you gentlemen are—what we are learning is that you come out of that 7 percent of the budget. You're not part of the defense budget—you're getting continually squeezed. And I'm just hoping that you are, in the process of presenting the budget that you have to present, you are able to present to us the real needs of this country so that we then don't have to overcompensate in years to come.

One, do we have a major problem upgrading our weather stations and so on? You know, it's an honest question. It's really a yes or no answer. Are we on target? Are you comfortable? Do we need more money? What's the story?

Dr. FRIDAY. The plan that we have issued forward for the modernization of the Weather Service is a program which, after it is

completed, I am convinced will provide quality weather information and services to this country. Services, not just simply information, because that's one of our critical areas.

I would be less than candid if I did not say that we could certainly move a little faster with more money, and the chairman has asked me to provide the data on doing that, and we will certainly do that for the record.

I would also be less than candid if I didn't say that I look forward to the 1991 and 1992 time frame in which we do have major installations occurring at the rate of one a week for the radars and one a day for ASOS and the like as being something that is going to be very difficult to manage and to do it effectively and make sure that it's done correctly with the trained personnel that will be absolutely essential to running this being phased in at the appropriate time.

I feel, from that standpoint then, that the proposed schedule for modernization that we have is one that is reasonable within the fact that we do have to live within that 7 percent of the budget that you've indicated.

Mr. SHAYS. But that's basically our judgment, though. It strikes me it's your judgment to tell us your needs, and then it's our judgment to say what we can provide. Then it's your responsibility to live within those. But it seems to me—and tell me if I'm wrong—that we have to know exactly what the needs are, and then we have got to make a determination of how we come up with the money, if we can. Then you've got to live within those needs. But it strikes me that you're doing that. It's like the administration has said, "This is what you'll have." Now you're telling us that that's really your need, and I've got a problem with that, because I'm going to make decisions based on not enough information.

Let me just ask you another question. The reduction of—the budget basically shows in absolute terms about $97 million less; correct? I'm talking total.

Mr. BURTON. That's right.

Mr. EVANS. That's correct.

Mr. SHAYS. But I also understand that the way contracts lead in satellite procurement and so on, there is about $111 million less expenditure in this next year's budget than the year to follow. Is that correct?

Mr. BURTON. That's correct.

Mr. SHAYS. So is it fair for me to say that there's basically, in essence, a $14 million net increase in terms of current service levels? I mean am I—I'm subtracting out the $97.5 million and the $11.4 million.

Mr. BURTON. Mr. Shays, the basic increase, as you noted, represents the hardware acquisitions that we're undertaking. NEXRAD is an example of that.

Just getting back to your question with regard to our needs being met on the issue of modernization, I think it is fair to say that Weather Service modernization in the recent past, in the last several years, has represented a major initiative on the part of the administration as well as the Department of Commerce, and, as Dr. Friday has said, I think we are very much on target.

The modernization proposal that has been received by the committee is one that we are very comfortable with and one which will demonstrably improve weather services in the country. And within the contract that we have with our contractors, Unisys, which has been mentioned, and others, I think we are moving ahead apace. We think we are in good shape on that, and once modernization is in place we will have a much better service in this country.

Mr. SHAYS. Thank you.

Just one last point, and basically I have to respond with imperfect information, but, again, as a new member of this committee, getting to the Landsat operations, it strikes me that the contractor basically has us right where he wants us. And if I had a definition of the Golden Fleece Award, this whole thing would fit right into it, and I just want to say that I'm going to get more and more interested in this issue, because I think it is a giant rip-off, very honestly. It's a giant rip-off, and I hope to God that you gentlemen are as diligent as you have to be, because I think this issue is going to be more and more interesting to the general taxpayer.

Thank you, Mr. Chairman.

Mr. SCHEUER. Thank you, Congressman.

Congressman David McCurdy.

Mr. MCCURDY. Thank you, Mr. Chairman.

Gentlemen, I was looking at the witness list, and I was looking at all the different agencies listed in the subdivisions. Are there any vacancies remaining in this assistant secretary, under secretary—I can't keep them all straight in Commerce. But in the areas that you all operate in, have they all been filled, or have there been people named or waiting for confirmation? What is the status on that?

Mr. EVANS. We're the carry-overs, Mr. McCurdy.

Mr. MCCURDY. Well, I wasn't addressing it as far as your positions. I'm just curious what is the—has there been an announced plan for filling slots?

Mr. EVANS. Not that I'm aware of.

Mr. MCCURDY. You are uncertain as to your own future? As candid as you can be. I'm not trying to put you on the spot, I'm just trying to figure out how well organized Commerce has gotten as we're going through this transition, and I would hope that you are better organized than the Department of Defense has been for this past few months. At least you have had a Secretary. I am just trying to find out where you are.

Mr. EVANS. Mr. McCurdy, as of the present time, the incumbents, the chief scientist and the assistant secretary and the under secretary, are those that were appointed by President Reagan and confirmed by the Senate.

It is my understanding that there is a vigorous search going on by the Secretary and by White House personnel to replace those positions right now or to put people in that. There has not been any announcement as yet.

Mr. MCCURDY. So are those the top three positions?

Mr. EVANS. Yes, sir.

Mr. MCCURDY. It is the administrator—

Mr. EVANS. The administrator, the deputy administrator, and the chief scientist.

Mr. MCCURDY. And the chief scientist.
Mr. EVANS. Yes, sir.
Mr. MCCURDY. So the top three slots have not been filled.
Mr. EVANS. No, sir.
Mr. MCCURDY. Okay.
Mr. EVANS. However, since I have informed Secretary Mosbacher of this and it is official, I am leaving the position effective some time this summer based upon finding a replacement and getting somebody confirmed in the office. I will stay there until they find an individual. I am going to the academic community, to the Texas A&M University in Galveston. So I will be there in the summer and the fall, so I'm going back to the academic community.
Mr. MCCURDY. How many other positions below those three are in question, or have they been firmed up? I'm trying to find out the volatility or the—
Mr. EVANS. A fairly large number of the Schedule C's that we have have been replaced or are in the process of being replaced. I think all of the key positions that we have have actually been replaced. The only ones that are currently—the incumbents that there has not been an announcement on for—of intent, are the three top positions.
Mr. MCCURDY. Well, just as a note, I think this is a bipartisan concern, and that is, on this committee, that if NOAA expects to have any measure of success vis-a-vis the budget in this cycle, you had better be able to have your best foot forward. And if you spend all the time—and this is a message to the Secretary, I guess, and I would hope someone would copy it in the record and submit it to the Secretary, and that is, if these positions are not filled, the Budget Committees are meeting and ongoing, and I realize you don't have—the Bush administration doesn't have its own budget here, but you have changes to the budget, and if this is a priority area—you know, we heard throughout this campaign what issues were discussed, and there weren't a lot of them discussed.
But one of the issues that was discussed, that there was going to be a new education President, that there was new emphasis on competitiveness, and in technology he was going to play a role. At the same time, you know, we haven't filled these positions, and we have got a lot of people up there in Budget Committee that don't agree with our position and understanding of the need for technology and investment in technology. And we're going to mess around and get the budgets cut, and, in the meantime, they are flitting around trying to fill the positions, and, you know, you get it from the other ear, and I don't like that.
I think someone ought to make that clear to the Secretary, and maybe my ranking Republican Member and others on that side may have more influence, but let me tell you, it's distressing.
Mr. EVANS. Let me clarify one thing. I think that there may be some misunderstanding. The major technical positions within NOAA are filled by career people. The people sitting at this table—Dr. Thomas is a career person; Mr. Pyke is a career person; Dr. Friday is a career person; and the head of the National Marine Fisheries Service is career. The only noncareer person currently is at the National Ocean Service, as the only AA who is not, so that the only non-career position—

Mr. McCURDY. I understand. I'm not questioning your technical ability. I think the technical ability is there. I am talking about your political ability to get the support for your technical folks, and if you don't have that political muscle up here on the Hill, quite frankly, or in the administration, within the administration, then your technical people aren't going to be there very long. Dr. Friday can go out and make a heck of a lot more money, you know, consulting or doing something with some industry.

Mr. SCHEUER. If the gentleman would yield, I would just as soon you not plant those kinds of ideas in Dr. Pyke's mind right now.

Let me mention that I have been in close communication with the Bush administration on their appointments for this agency and others, and I can understand their concern in being very selective, in making sure that they choose the absolute best and the brightest.

So I, too, share your urgency of their speeding up the process, but I also have a closer view of exactly what they are looking for and what they are trying to avoid, and so I think the best thing that we could do is to operate with the situation as it sits but continue—

Mr. McCURDY. That's all well and good, if I can reclaim my time. The problem is, we are going to waste a year's cycle, and you will here be next year coming back and trying to rebuild after the cuts you are going to get this year because you didn't have those, quote, best minds in place. And it is not a very attractive proposition when you are trying to keep programs alive as well.

Let me go back to the substance of the questions I want to get into.

Mr. SCHEUER. Would the gentleman yield to me very briefly, and then I'll yield back.

Mr. McCURDY. Certainly.

Mr. SCHEUER. I want to emphasize the importance of time. Time costs. Time costs lives; time costs money. If you don't believe it, Dr. Friday—and I know you do; you have given us wonderful testimony; we have the greatest admiration for you—read over the transcript of that hearing that was held by Congressman Tim Valentine and Congressman David Price at which I had the honor and the privilege of being present and observing.

Hundreds of millions of dollars of damage directly attributable to the fact that the Weather Service was operating with obsolete, broken down, out of repair equipment and facilities, as I stated, that were more relevant and symbolic of a Third World country in Asia, Africa, or Latin America than these United States of America. They cost hundreds of millions of dollars directly attributable to that disgraceful state of disrepair and obsolescence of the equipment, and, Dr. Friday, I want you to know, there was a cost of lives, a cost of human lives, American citizens, who were lost because of that decrepit, obsolescent procedure.

We are not just champing impatiently just to criticize the administration, we're really not, we are totally bipartisan up here. This subcommittee—in fact, the science committee itself—rarely gets involved in political assaults one way or the other, and this is a particularly wonderful subcommittee. We are really interested in the

issues of America being preeminent once again and recovering its lost position of preeminence in communications technology.

We want to save the dollars, we want to save the lives, and when you do your little evaluation of your cost-benefit analysis, I hope, of whether it makes sense to accelerate this contract with Unisys to deliver the Doppler radar, count as an identifiable, verifiable, statistically verifiable cost of time being lives and a lot of money, in the hundreds of millions of dollars.

I don't know how you quantify a human life, but that is part of what you are going to have to do, because delay means lives, and when you talk about Doppler radar it is perfectly self-evident to anybody that the availability of that equipment on the cutting edge of new technology will save lives. That is why we bought the system in the first place, for goodness sake, and when you talk about the inobsolete, out of repair equipment that the National Weather Service was struggling with in North Carolina—boy, read the transcript of that hearing, Dr. Friday; have your staff point out the pages to you; spend 15 minutes reading it; it will concentrate your mind on the identifiable costs of delay. Okay?

I yield back with apologies.

Mr. McCURDY. I thank the gentleman, and I think what the chairman is really saying as well is that the technical people understand the issues, and you are close to it, and you love the science, and that is why you are doing what you are doing, because you are sacrificing because, again, you can make more money doing something else. You are here because you love the science that you are working in, and it's vital and necessary.

What we are trying to emphasize is the need for you to get the message out not only within the administration but to the American public of the benefits. It is an area that we take for granted. People turn on the morning news show or the television for the weather report, and they see these nice, glitzy photographs, the satellite photos, and they think it's just there, it's just, you know, a way of life, and it's nice to have, you know. But until they realize what it takes to pay for that and the science that it takes to develop those and the next generation of what that will be, then, again, they will opt for some other program, because they assume that this is all—either the local television pays for it or someone else. I don't think they understand the role of the Federal Government in developing this technology, and that message is not only a technical message but it is also a political message, and that's why I think it's important that we get the political appointees in place in order to convey that message, and I'm hoping, as the gentlelady describes, that perhaps they will be better in sending that signal than we've had in the past and that this administration is more supportive of that kind of technology. That remains to be seen.

Let me ask one question though, or a couple of questions, back to the issue of Landsat and the commercialization. In 1984, under that act, the commercialization act, it explicitly called for NOAA, along with NASA, to conduct applied land remote sensing research, and I want to ask, does NOAA still recognize the need for this type of research, Mr. Pyke?

Mr. PYKE. Mr. McCurdy, we recognize the importance of research in this area and recognize the role that NASA has played in continuing research in this field.

Mr. MCCURDY. As a part of a memorandum of agreement signed between NOAA and the University of Oklahoma in 1986, NOAA agreed to support the establishment of three cooperative institutes for applied remote sensing. It was understood that NOAA would provide a limited amount of funding for basic research so that these institutes could work with private industry and *academia* to conduct the research.

Yet, as your budget indicates, these institutes have been seriously neglected. Despite this, the institute at the University of Oklahoma has participated in a number of important projects in applied remote sensing. For instance, working closely with the GEOSAT Committee, the institute is conducting research on surface expression of subsurface structure, a digital stereo work station, and expansion of its image archive.

As you know, the institute also conducted a study which provided data on the energy resources user needs for an advanced civil earth remote sensing system as part of NOAA's post-Landsat 6 studies.

Now does NOAA recognize as important the work that has so far been conducted by these cooperative institutes?

Mr. PYKE. We are pleased with the work that has been performed on our behalf by these institutes, including the work at the cooperative institute at the University of Oklahoma. I would like to say, Mr. McCurdy, that we are very pleased to have supported that work as a part of a study of the long-term future of the Landsat program during the past year. We are also very pleased to have placed in residence at the university a senior researcher to help contribute to the overall results of that R&D activity.

Mr. MCCURDY. As a part of your post-Landsat 6 action plan, what does NOAA recommend for continuing support for cooperative applied research?

Mr. PYKE. We have not addressed plans for the future as of this time with regard to research in this area.

Mr. MCCURDY. You do not have any plan?

Mr. PYKE. We have not yet addressed a plan for the future in this area.

Mr. MCCURDY. You are developing a plan or going to develop a plan?

Mr. PYKE. Well, our future with regard to the Landsat program will be, in large part, determined, we believe, as a result of the course to be set by this National Space Council review relative to Landsat policy and the resulting deliberations based on the outcome of that review.

Mr. MCCURDY. But basically you said yes to all those questions, that you are pleased with the research, you believe that the cooperative institutes are valid, and that you continue to have responsibility to perform this function. Then why isn't there funding provided?

Mr. PYKE. At this time, sir, we are providing the equivalent of funding, for example, to the University of Oklahoma. We met the highest priority request that they had when they came to us

during this past year, which was, "Please send us out a senior research scientist who could help us both in performing research and in providing—being an adjunct member of the faculty and assisting in the educational process."

Mr. MCCURDY. But that's the only funding; it's basically in-kind funding by provision of service.

Mr. PYKE. At this point in time, that is what we envision.

Mr. MCCURDY. If you had more funds in there, would cooperative *institutes be one of the priority investments?*

Mr. PYKE. It is not at all clear where the cooperative institutes would fall with regard to the other priorities within NOAA. We certainly do recognize the importance of the cooperative institutes and the contributions that they have made in the past.

Mr. MCCURDY. Thank you.

Thank you, Mr. Chairman.

Mr. Chairman, by the way, I know you are concerned about NEXRAD, and having had some experience with the Department of Defense through the Armed Services Committee, I can assure you that even though some of these contractors are so-called mega-corporations and producers, it is very difficult to produce beyond a certain rate. And I'm not defending or trying to put myself in Dr. Friday's shoes, I'm just saying that I would be interested in seeing those figures, but I think we also have to be careful that we don't create a surge or a bow wave that they can't handle and would hate to be in a position of creating waste or inefficiencies in the production cycle by pushing them too hard.

We found that, actually, in the Department of Defense over eight years with Cap Weinberger, they threw so much money at it, and, quite frankly, they didn't spend it very well, and I want to make sure that we have an organized plan here.

Mr. SCHEUER. Well, I hope nobody is suggesting that we bring all the floors of the procurement process in the Defense Department into the procurement process for NEXRAD; God forbid, and Heaven forbid.

What I do think is—well, let's assume for the purpose of the argument that it costs 2 percent or 5 percent more to accelerate the program from a 3 and a half, or 4, or 5 year program to a one year program. Then you'd have to sit down and sharpen your pencil and say, "Does it pay to pay 5 percent more to get this equipment installed in a 12 months period rather than the 15 months period?" and what I suggested before to Dr. Friday, with all respect, was that if they factor into the computation the costs of not having it that are hundreds of millions of dollars—that was spread all over the testimony in David Price's and Tim Valentine's hearing—hundreds of millions of damage directly attributable to the lack of state-of-the-art equipment, and you factor in the cost of human lives, which the actuarial specialists know how to do in the insurance business, you might find that it's a very clear cost-benefit to going ahead, paying a little bit more, but having that equipment on the line saving lives and savings hundreds of millions of dollars.

What I am suggesting is that we find out from the point of view of a cost-benefit analysis what is the optimum rate of going ahead to avoid waste, and waste means lives and destruction as well as procurement dollars.

There might be a slight increase in procurement costs that would be many times made up for by the savings in dollars and the savings of lives, and all I'm asking is that we do a thoughtful cost-benefit analysis which factors all of those elements into the computer, and I appreciate the gentleman's cautionary remarks. He's quite right.

I have one or two questions left for this panel, and then I'm going to thank you with the greatest of appreciation for your excellent testimony and for many months and years of outstanding cooperation we have received from you.

First, last January the GOES-West weather satellite failed, leaving the United States with only one operational geostationary satellite. Now what are NOAA's contingency plans should the remaining satellite, GOES-East, also fail?

Mr. EVANS. We share your concerns, Mr. Chairman. We do have a contingency plan, and I will let Mr. Pyke expand on it for me.

Mr. PYKE. Mr. Chairman, we have already gone to one contingency plan which we were able to put into place within a matter of hours after the failure of GOES-East, also known as GOES-6. We have gone to a backup situation in which we moved the one satellite over to the central part of the United States, moving it back and forth to better cover the winter storm season and the hurricane season, depending on the time of year.

We supplement the GOES data with data from our polar orbiting satellites. We supplement it also with data from ocean buoys, and we are pleased to have access to some geostationary weather satellite data from the Europeans as well as from the Japanese.

Although we certainly hope and plan to have the next GOES satellite, known as GOES-I, flying and in great shape before the present GOES satellite fails, we do have a contingency plan that if GOES-7 fails we will be able to rely on the data from our polar orbiting satellites to give us similar coverage but not nearly as often and in not nearly as much detail as we have been accustomed to and as we depend on.

We have also been—

Mr. SCHEUER. And not only as we depend on but about 130 countries around the world depend on. Is that not true?

Mr. PYKE. Yes, sir. And we also have been engaged in serious discussions with the Europeans about the prospects for moving one of their geostationary meteorological satellites over a little further toward the United States should this eventually occur so that we can take advantage of a little better coverage over the Atlantic area in the event of this particular situation.

Mr. SCHEUER. Could you see the potential of working cooperatively with the Europeans and the Japanese on these weather satellites, and perhaps even the Russians in this new era of glasnost and perestroika, whereby we consolidate our forces and have more of a sharing both in the costs and the benefits of satellite information technology?

It seems to me at first glance—and, after all, you were the one that brought it up, I'm just reacting to you, but it's in the back of our mind because we're thinking about burden sharing across the board in all kinds of weather space enterprises. Is there an opportunity here for having a sort of global perspective and having the

European Community, the Americans, the Japanese joining together and producing a plan for the satellite orbiting and passage, and so forth, that serves us all with maximal efficiency?

Mr. PYKE. Mr. Chairman, there is not only an opportunity but we have done so in the past and continue to do so at the present time. We have an extensive coordination mechanism with the other nations of the world that operate weather satellites, whether they be geostationary or whether they contribute to our polar orbiting system.

For example, with regard to our polar orbiting satellites, we are very pleased that the other countries, Europe in particular, have contributed expensive instruments. For example, the microwave sounding units on our polar orbiting satellites are provided by the United Kingdom; the search and rescue capability, that system on our polar orbiting satellites, is provided by France and Canada; the data collection system, known as Argos, the instrument that flies on our polar orbiting satellites is provided by France.

These contributions by the other countries represent a substantial reduction in cost which would otherwise have to be borne by the American taxpayer, and, in turn, of course, we subscribe to the free and open sharing of the meteorological data that is acquired through the use of these satellites.

Mr. SCHEUER. That's very encouraging. I'm delighted to hear that. If you can think of any other opportunities for cost sharing, burden sharing, economy of effort, you know, let us know and perhaps we can take it up with representatives of those governments.

What is the status of your plan, Dr. Evans or anyone, to cap the cost growth of the GOES program?

Mr. EVANS. We're negotiating very vigorously with NASA at the present time, not really as successfully as I would have liked to have. But we do have some assurances that we are going to place a cap on the GOES. I don't know what the most recent deadline that we've established in negotiation with NASA now—when it it, Tom? By this summer or this fall?

Mr. PYKE. NASA has keyed the completion of the capped contract, or the restructured contract, to the delivery of the first flight instruments for the GOES-I spacecraft. At the present time those are not expected to be available until at least the end of this calendar year. So the negotiations are well underway, but it is our understanding that the negotiations between NASA and the contractor for the GOES. Next series of spacecraft will not have led to a restructured contract, as we have requested be done, until at least early next calendar year.

Mr. EVANS. Mr. Chairman, I think the concern of this committee has been very helpful, and will continue to be helpful, to make sure that that process and that cap goes forward. I think that we need to have that support. I think it's been very important to us so far. We still have great concerns about that.

Mr. SCHEUER. We're all concerned about these runaway costs, and I think all of us have a visceral feeling, based on history and experience, that a pure and unadulterated cost-plus approach is an invitation to disaster. We simply shouldn't go down that track.

Let me ask one question about NEXRAD, and the National Weather Service. The budget shortfall for the National Weather

Service last year was covered by reprogramming 13-1/2, 13.6 million dollars from NEXRAD to the Weather Service. Now, we take a very dim view of that. We think each of these two programs are totally justifiable, have an enormous potential for paying for themselves many times over in lives and money, and we don't want to see one compromised for the purpose of avoiding disaster for the other.

So the question is, does NOAA plan to take money again, to reprogram money yet once again from NEXRAD to prevent the closure of these Weather Service offices this year, as Secretary Mosbacher has pledged to avoid. As I said before, by our computations, it will cost about 25 or 26 million dollars to maintain the current level of services and avoid closing weather stations.

How are you going to meet that, and, to state it again, do you contemplate reprogramming funds from NEXRAD to the National Weather Service to avoid the disaster in the Weather Service but to create what we think would be a very, very threatening situation, and that's NEXRAD.

Mr. EVANS. Mr. Chairman, there are no—we don't really know what the definite plans are, as to whether or not there is going to be a plan to reprogram or request reprogramming from NEXRAD to cover the 1990 shortfall. That is one of the considerations that is being looked at right now, both by the Department of Commerce as well as OMB. That package has not been finalized yet. We are vigorously looking for ways that we can cover this internally within the Department of Commerce without endangering the importance of the NEXRAD system. We're very concerned, as you are, that we get this system on line as fast as we can. In fact, actually Secretary Mosbacher used the North Carolina incident as an example of his feeling for the importance of getting this system into modernization.

Mr. SCHEUER. He is aware, is he, of that North Carolina disaster?

Mr. EVANS. Yes, sir, he is very much aware of this, and he actually used it in his confirmation hearing. He used the example of North Carolina, with obsolete equipment that wasn't functioning, with all of the problems that where there, in comparison with similar tornados of equal strength that occurred in Boulder, Colorado—I mean in Denver, Colorado. And they were able to, with the new equipment, say when the tornados were going to be there, the area. There was a lot of damage, but there were no lives lost and there were no injuries. So that's very important, and the Secretary and the administration are very much aware of this and we're trying to come up, under the fiscal constraints that we have, and this committee is very much aware of those. We're trying to come up with the very best solution that we can come, but still fall within the fiscal constraints that we currently have.

Mr. SCHEUER. Well, it's assuring to know at leas the Secretary is up to speed on what happened in North Carolina. That certainly must concentrate his mind, too.

I would request that you make some inquiries of the Secretary and inform this committee, perhaps write us a letter, and tell us specifically if there is any intention of reprogrammed funds out of NEXRAD to save these station closures. I appreciate the fact that the Secretary has assured us that there will be no station closures

this year, but we want to know whose hide that's going to come out of. We don't want it to be—we're very strong that it not come out of NEXRAD's hide. So would you write us and let us know—

Mr. EVANS. We'll pass that information on and we will send you that information.

Mr. SCHEUER. In a timely fashion.

Mr. EVANS. Yes, sir.

Mr. SCHEUER. Because we're going to raise hell if we hear that's being contemplated. I want the time to do it.

Mr. EVANS. I'm convinced of that, Mr. Chairman.

[The requested information follows:]

Consideration of any FY 1990 budget adjustments to prevent weather station closures and reductions in services is ongoing within the Administration. We will provide complete information when the proposal is transmitted to the Congress.

Mr. SCHEUER. Okay. This has been an extremely productive and helpful hearing. We want to thank you again. We have a long history of very cooperative and effective relations with every single person at the witness table now. We want to thank you for your past and present cooperation and enlightenment, and we look forward to continuing down that same path in the future.

Mr. EVANS. Mr. Chairman, would you, with—I would like to have you deliver a message to the members of the subcommittee, and especially to Mr. McCurdy, to set his fears aside, that although there have not been people put in place as far as the Administrator, I am the Administrator of NOAA, will continue to do that, will do that vigorously. Mr. Burton will also continue to do the excellent job that he's done over the last year, that nobody's going to drop the reins, that we're going to continue to service that agency. We all feel it's very important, and that we're going to continue to do that until we have somebody in place and operating at full speed.

I wish you would pass that assurance along to Mr.—

Mr. SCHEUER. I certainly will. That assurance is very welcome and very encouraging. We appreciate it and we appreciate your testimony. Thank you very, very much.

Mr. EVANS. Yes, sir.

Mr. SCHEUER. Now we'll ask the last two witnesses to come to the witness table, Dr. Joanne Simpson, President of the American Meteorological Society, and Mr. John Quadros, President of the National Weather Service Employees Organization.

Dr. Simpson, we're very pleased that you're here today. Your testimony, as prepared, will be printed in full in the record at this point, so why don't you chat with us for five or six or seven minutes informally, and then when we've heard from Mr. Quadros, I'm sure we'll have some questions for both of you.

STATEMENTS OF JOANNE SIMPSON, PRESIDENT, AMERICAN METEOROLOGICAL SOCIETY; AND JOHN QUADROS, PRESIDENT, NATIONAL WEATHER SERVICE EMPLOYEES ORGANIZATION

Ms. SIMPSON. Thank you, Mr. Chairman.

I very much appreciate this opportunity to appear before your subcommittee today because I and the community that I represent, of atmospheric scientists and forecasters, which is the American Meteorological Society, the AMS, deeply share your concern re-

garding NOAA's budget and funding problems. The cutting edge of science and technology has to be applied to carrying out NOAA's atmospheric mission.

I'm going to present an overview of the priorities for atmospheric science and services as set forth in a position paper which our Society prepared, together with the University Corporation for Atmospheric Research, called UCAR. UCAR is a consortium of 58 universities involved in atmospheric and related sciences. And then I will put in a few of my own views about NOAA's budget situation.

NOAA's serious budget problems became apparent during the preparation of this paper. This summarizes our consensus on those atmospheric problems which must be given top priority for the present and future safety and economic well-being of the Nation, given the prevailing, very tight budget situation, the serious lag in forecasting capability, and the threatened condition of our environment.

This is attached to my written testimony, and if it's all right with you, Mr. Chairman, I would like to have it on the record as part of the testimony.

Mr. SCHEUER. Are you talking about this pamphlet?

Ms. SIMPSON. This pamphlet. Because it covers a great many of the things that you have already asked about.

Mr. SCHEUER. That's fine. There being no objection, so ordered.

Ms. SIMPSON. Thank you.

The consensus of this document is that there are two urgent priorities that have to be acted on. Firstly, the improvement of the warnings of severe weather events, and secondly, better monitoring, understanding and evaluation of the risks posed by man-made changes in the global climate system. These risks include ozone depletion, desertification, drought and the warming that most scientists expect will result from the increased carbon dioxide and other trace gases.

It is important to recognize, however, that before we can clearly identify the effects of man's activity and thereby develop policy responses, we must have a better understanding and documentation of the very large natural variabilities that the system undergoes.

The 12 Government agencies involved in environmental research and related policy, including NOAA, have collaborated in preparing a report. I believe this was alluded to during the NOAA testimony. It's a short report, which just came out about a month ago. It gives all the agencies involved, including NOAA. It gives the long-range plan for global change, NOAA's role in global change, and the budget for each agency for the next two years. I had hoped Representative Schneider would be here when I spoke, because she particularly asked about this report.

I am pleased to note that NOAA's budget as submitted by the administration allows for more than doubling of its allotment for global change, so that it can undertake its required partnership in the global change study, as laid out. I will leave one of these here because you asked for it.

Mr. SCHEUER. We're very pleased to have it.

Ms. SIMPSON. In the AMS/UCAR paper, we view global change as a problem equally urgent to that of improving weather warnings and forecasts. However, since we do have a national effort on

global change, the rest of my testimony will be concerned with the upgrade in forecast and warning capability, which as you said, not only is costing time but lives. NOAA is the lead agency in carrying out the Weather Service mission in this country.

To carry out the recommendations which we have made and you have repeated, except for one point, there are two parallel streams of action that are required. Firstly, the modernization of the technology and the restructuring of the Weather Service, and second, something which has not yet been discussed at this hearing, a closely associated research program focused on understanding the smaller scale weather, the precipitating cloud systems which are the direct source of tornados, floods, hail, heavy snow, and also large rain clouds that are principal drivers in squall lines and tropical hurricanes. The Nation has embarked on the technology part of the modernization, as has been discussed here this morning, but it still has not taken the policy decision to initiate the associated research program, which we call STORM. That is an acronym standing for STormscale Operational and Research Meteorology.

With regard to the Weather Service modernization, there are five, tightly-meshed components—and you've mentioned these already, so I won't—more than support everything you've said in a desperation fashion. These components must be moved forward in a synchronized, orderly fashion so that the whole system is in place as soon as possible, and this should be by 1995. Our Nation urgently needs the better forecast that this new technology facilitates. In addition, as you said, the existing systems are becoming obsolete and increasingly difficult and expensive to maintain.

The first three components of the Weather Service modernization are measuring systems, that you have mentioned, the new Doppler radar network NEXRAD, the Automated Surface Observing Systems, ASOS, and the next generation of satellites—geostationary, GOES I thru M, and microwave-upgraded polar orbiters.

I am pleased to learn that the President's plan is for two each of these operational satellites to be deployed at all times to provide full coverage of the developing weather systems which affect our Nation.

The NOAA FY 1990 and outyears budget for finishing the satellite development, launch and ground systems appears satisfactory, except that it assumes every link in the chain is going to work out perfectly and allows no leeway for a failed rocket or a delayed instrument. In the case of NEXRAD, any delay in the orderly deployment due to budget shortfalls or making up for budget shortfalls is not only unwise but uneconomic. The radars are necessary for advanced detection of the symptoms of nearly all incipient floods, tornados and downbursts. Postponing the systematic installation of these radars will not only make the network more costly in dollars in the long run, but its early use will be less efficient and there can be more lives lost from inadequate equipment. The ASOS, I don't know whether the 1990 budget is adequate or not. That should be looked into carefully.

The next and vital key component of the upgrade is the Advanced Weather Interactive Processing System, called AWIPS. This is the nerve center for data ingest, integration and analysis at the warning and forecast stations nationwide. The AWIPS has the

most acute funding problem. I read the testimony given on AWIPS before this committee last March. We seem to have again this year the same problems as last year, when only five million was requested in contrast to the approximately 20 million which was needed, and which was made available by the Congress in 1988. It is essential that the AWIPS be kept in phase with the other components of the upgrade. I don't see how the program can be kept on schedule without a sizable increase above the amount requested in the FY 1990 budget.

The fifth component of the Weather Service upgrade is based on new computational power at the National Meteorological Center, which develops and operates the numerical prediction models upon which forecasts are based. If we're going to be able to utilize the advantages of the more closely spaced and more frequent and better measurements to predict the rapid onset of severe weather, finer mesh numerical models have to be developed and run operationally at NMC. A necessary requirement is for two new Class VII supercomputers. The 1990 budget only contains the funding for one.

Before I move to the final part of my testimony on the needed research in the STORM program, there are two aspects of Weather Service—restructuring and closure of stations—that need to be discussed. You have discussed these pretty much as I wanted to say, but I wanted to emphasize that again the meteorological community is strongly in agreement on this.

The restructuring of the Weather Service must take place after the implementation of the new technology. I've read the strategic plan which was forwarded to the Congress by the Department of Commerce. In broad outline, it sounds okay. It lays out a scheme which highly correlates the technology with the numbers of warning and forecast offices. The widespread vulnerability of this country—there's no section of this country which is immune to flooding and severe storms—calls for a decentralized system for preparing the warnings. However, the plan is vague on the actual staffing of these stations. The quality and training level of the staff is not specified, as well as the capability to stay in touch at the local level, to communicate to the local people the warnings.

I'm not an expert in this area, but what is being proposed in the strategic plan is a big change from the way things are today. It must be looked at very carefully.

I also notice in the President's 1990 NOAA budget there is substantial reductions in the number of people, the associated budget, and the mention of closure of weather stations. Now, since then, Secretary Mosbacher has said there will be no closing until the modernization has been completed. I applaud this wise decision.

However, knowing just how tight the budget of the Weather Service has been for many years, I cannot see how it's possible to carry out Secretary Mosbacher's decision and still reduce the personnel and dollars in 1990. Where is the money going to come from?

Mr. SCHEUER. Dr. Simpson, we agree with you. And you must have noticed that—

Ms. SIMPSON. I noticed.

Mr. SCHEUER [continuing]. There was a great deal of questioning along those lines.

Ms. SIMPSON. I am very glad to hear you be concerned about that, because I fervently hope and the community hopes that these shortfalls are not patched up by reductions and delays in implementing the technology plan.

Mr. SCHEUER. Or delays in implementing another technology plan, which might be NEXRAD, to say—

Ms. SIMPSON. That's exactly what I was worrying about.

Mr. SCHEUER. Dr. Simpson, you're running a bit over your time. Could you come—

Ms. SIMPSON. Okay. Well, let me just finish on STORM, because if you must have the hand-in-hand research program—this is for the Congressman who asked about the model of the European center, this is where we have failed. We do not have research and operations working closely hand in hand, and the STORM program is what proposes to do this. It has a detailed plan already written out. It has nothing for it in the 1990 budget to get it off the ground, to bring forecasters and researchers together.

The data from the NEXRADs will not even be recorded for anybody to use, except at six stations. This has not come up in the testimony before, and it's extremely important emphasize that for 1990 only five to seven million dollars are needed STORM. This is only 10 to 15 percent of the cost of the technology upgrade, and this is the only way to make the technology upgrade cost effective—to save the lives and the property that you were talking about. And the cost of not taking this action will be, as you said, a great deal greater.

[The prepared statement of Joanne Simpson follows:]

Subcommittee on Natural Resources, Agriculture Research and Environment

Committee on Science, Space and Technology

Hearing on the FY 1990 NOAA Budget

by

Dr. Joanne Simpson

April 4, 1989

Thank you, Mr. Chairman. We appreciate the opportunity to testify before your Subcommittee today. My name is Joanne Simpson. I am the President of the American Meteorological Society, consisting of about 10,000 members who are professionals in the atmospheric and related sciences and applications. My regular employment is as Chief Scientist for Meteorology at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

We share the concern you expressed in your invitation regarding the resources available to NOAA. The cutting edge of science and technology must be applied in carrying out NOAA'S atmospheric mission. The nation cannot afford patchwork measures which are virtually always cost-ineffective.

I intend to present an overview of the atmospheric science and service priorities as set forth in a position paper prepared by our Society and the University Corporation for Atmospheric Research (a consortium of 58 universities

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involved in atmospheric and related sciences). Then I will provide my own personal views on the atmospheric portion of the NOAA budget. I am very familiar with NOAA's needs. I served in that Agency for ten years myself. My husband was in the Weather Service for 35 years as Deputy Director, Deputy Director of Research and Director of the National Hurricane Center where we worked very closely together.

NOAA's serious budget problems became apparent during the preparation of the AMS/UCAR paper for the incoming national Administration. The AMS/UCAR paper summarizes our consensus on those atmospheric problems which must be top priority for the present and future safety and economic well being of the United States, given both the prevailing tight budget situation, the serious weather forecast lag and the threatened condition of our environment. This October 1988 publication is entitled "The Changing Atmosphere - Challenges and Opportunities". It is attached to my written testimony, and if you have no objection, Mr. Chairman, I respectfully request that it be entered in the hearing record.

The consensus of the AMS/UCAR document is that there are two urgent priorities which must be acted upon. First, the improvement of the warnings of severe weather and flooding events. Second, better monitoring, understanding and evaluation of the risks posed by man-made changes in the

global climate system, such as ozone depletion, desertification, drought and the warming which most scientists expect to result from the increased carbon dioxide and trace gases released by man into the atmosphere. It is important to recognize that before we can clearly identify the effects of man's activity and thereby develop policy responses, we must have a better documentation of the very large natural variabilities in the global climate system. The twelve government agencies and departments involved in environmental research and related policy, including NOAA, have formulated a national research effort, summarized in the report entitled "Our Changing Planet: A U.S. Strategy for Global Change Research." I am pleased to note that NOAA's FY 1990 budget, by more than doubling the modest FY89 allotment for Global Change, enables NOAA to undertake its required partnership role with these other organizations. This emphasizes NOAA's unique requirement and capability in monitoring the numerous variables that determine climate. This means sustaining, archiving and making available long-term observations in both oceans and atmosphere. There is also a low-cost but important upgrade in the computer capability for the frontline climate prediction modeling in progress at NOAA's Geophysical Fluid Dynamics Laboratory.

In the AMS/UCAR paper, we view Global Change as a problem as urgent as improving weather warnings and forecasts. We have a national effort on Global Change.

Therefore, the rest of my testimony will be concerned with the upgrade in forecast and warning capability, since NOAA is the lead agency in carrying out the weather service mission in this country.

To carry out the AMS/UCAR recommendation regarding the severe weather and flood warnings and, more generally, improved weather forecasting, requires two parallel streams of action: First, the modernization and restructuring of the National Weather Service; and second, an associated research program focussing on understanding the mesoscale weather. Crucial examples are the precipitating cloud systems which are the direct source of many severe weather events such as floods, hail, heavy snow, and tornadoes, and are the principal drivers in the system of squall lines and tropical hurricanes. The nation has embarked on the modernization but still has not made the policy decision to initiate the associated STORM (STormscale Operational and Research Meteorology) program.

With regard to the Weather Service modernization, there are five tightly meshed components which must be moved forward in a synchronized orderly fashion so that the whole system is completely in place as soon as possible, hopefully by 1995. Our nation urgently needs the better forecasts that the new technology facilitates. In addition, the existing systems are becoming obsolete and increasingly difficult and

expensive to maintain.

The first three components of the Weather Service modernization are measuring systems, namely the new Doppler radar network (NEXRAD), the Automated Surface Observing Systems (ASOS) and the next generation of satellites, namely the geostationary satellites GOES I-M, and the microwave-upgraded polar orbiters NOAA K-M. I am pleased to learn that the President's plan is for two each of these operational satellites to be deployed to provide full coverage of developing weather systems which may affect the United States. The NOAA FY 1990 and outyears budgets for finishing the satellite development, launch and ground systems is apparently satisfactory, except that it assumes 100 per cent success in every link of the complex chain, with no allowance for a failed rocket or a delayed instrument.

Any delays in the orderly deployment of NEXRAD due to budget shortfalls is unwise and uneconomic. These radars are necessary for detecting in advance within the cloud systems the symptoms which yield floods, tornadoes and downbursts. Postponing their systematic purchase and installation will only make the network more costly in the long run and its orderly testing and early use less efficient. Therefore I support the large budget increase proposed for NEXRAD. On the other hand, I do not know whether the FY 1990 budget for ASOS is adequate because my understanding is that the production award of ASOS is planned for 1990.

The next and vital key component of the upgrade is the Advanced Weather Interactive Processing System (AWIPS), the nerve center for data ingest, integration and analysis at the Warning and Forecast Stations nationwide. The AWIPS has the most acute funding problem. I have read the testimony given on AWIPS before this Committee last March. We seem to have again this year the same problem as last year when only $5 million was requested, in contrast to the approximately $20 million which was needed and was made available by the Congress in 1988. The contracts for the definition phase have been awarded. It is essential that the AWIPS be kept in phase with the other components of the upgrade. I cannot see how the program can be kept on schedule without a sizable increase above the amount requested in the FY 1990 budget.

The fifth component of the Weather Service upgrade is based on new computational power at the National Meteorological Center. The NMC develops and operates the numerical prediction models upon which weather forecasts are based. To utilize the more closely spaced and more frequent measurements that are planned in order to detect and predict the rapid onset of severe weather and flood events, finer mesh numerical prediction models must be further developed and run operationally at NMC. A necessary requirement is for two new Class VII supercomputers, for which funds for only one are requested for FY 1990.

Before I move to the final part of my testimony on the

needed research in the STORM program, there are two aspects of the Weather Service - restructuring and closure of stations - that need discussion. With regard to the restructuring of the Weather Service which must take place after the implementation of the new technology, I have read the strategic plan which was forwarded to the Congress by the Department of Commerce. In broad outline, this plan does seem to follow the discussions which have been taking place the last few years in the meteorological community by laying out a scheme which highly correlates the technology with the numbers of Warning and Forecast Offices. It does call for a decentralized system for preparing the warnings. However, the Plan is quite vague on the actual staffing of these stations. The quality and training level of the staff is not yet specified, as well as the capability to stay in touch at the local level. I am not an expert in this area. But what is being proposed is a big change from today and one that must be carried out with great care. I assume that this information will be forthcoming with the presentation of a more detailed plan.

I also noted in the President's FY 1990 NOAA Budget that there are substantial reductions in the number of people, the associated budget, and the mention of closure of weather stations. Since then, Secretary Mosbacher has stated that there would be no closures or reductions in the existing stations until the modernization has been

completed. I applaud this wise decision. Knowing just how tight the budget of the Weather Service has been for many years, I cannot conceive of how it will be possible to carry out Secretary Mosbacher's decision and still have reductions in personnel and in dollars. I fervently hope that the shortfalls in resources are not patched up by reductions and delays in implementing the technology plan. This course of action would be multiply self-defeating as delayed implementation would be more costly. At the same time, such delays would postpone the time at which the labor-intensive obsolete systems can be phased out.

This last section of my testimony will concern STORM, the research program which must accompany the technological upgrade. These must proceed hand-in-hand in order to fully optimize what the new equipment can help us learn about weather processes. This in turn should provide a significant improvement in pinpointing in advance the occurrence of severe weather events. STORM is also needed to pave the way for still another, later major improvment in forecasting capability which will result when the new understanding of cloud and storm-scale processes are incorporated into much higher resolution numerical models.

An essential part of STORM is a closer linkage and two-way information transfer between key segments of the research community and the operational teams out in the

field at the Warning and Forecast Stations and particularly at the National Meteorological Center (NMC). It will take the interactive efforts of both the research and operational communities to use the new data to achieve greater physical understanding of the important mesoscale processes. Improved understanding must be implemented with numerical techniques to develop and test the finer-scale numerical prediction models and to proceed from the output of these models to the local forecasts, which incorporate the latest surface, radar and satellite data.

STORM must be a national effort analogous to the national effort on Global Change involving, with NOAA, the National Science Foundation (NSF), the National Space and Aeronautics Administration (NASA), the Federal Aviation Administration (FAA), the Department of Defense (DOD), and numerous universities. STORM has been carefully planned in a written document[1] by a large group of outstanding scientists from the universities and government agencies over the past several years, but no funding has been allocated to get it off the ground in the NOAA FY 1990 budget.

STORM will emphasize the development and use of the new observational and modeling capabilities. It will include experimental forecast centers where operational forecasters,

[1]The STORM plan, in a near-final draft, has been reviewed and endorsed by a subcommittee of the Federal Coordinating Council for Science, Engineering and Technology and by a National Academy of Sciences subcommittee of the Board on Atmospheric Sciences.

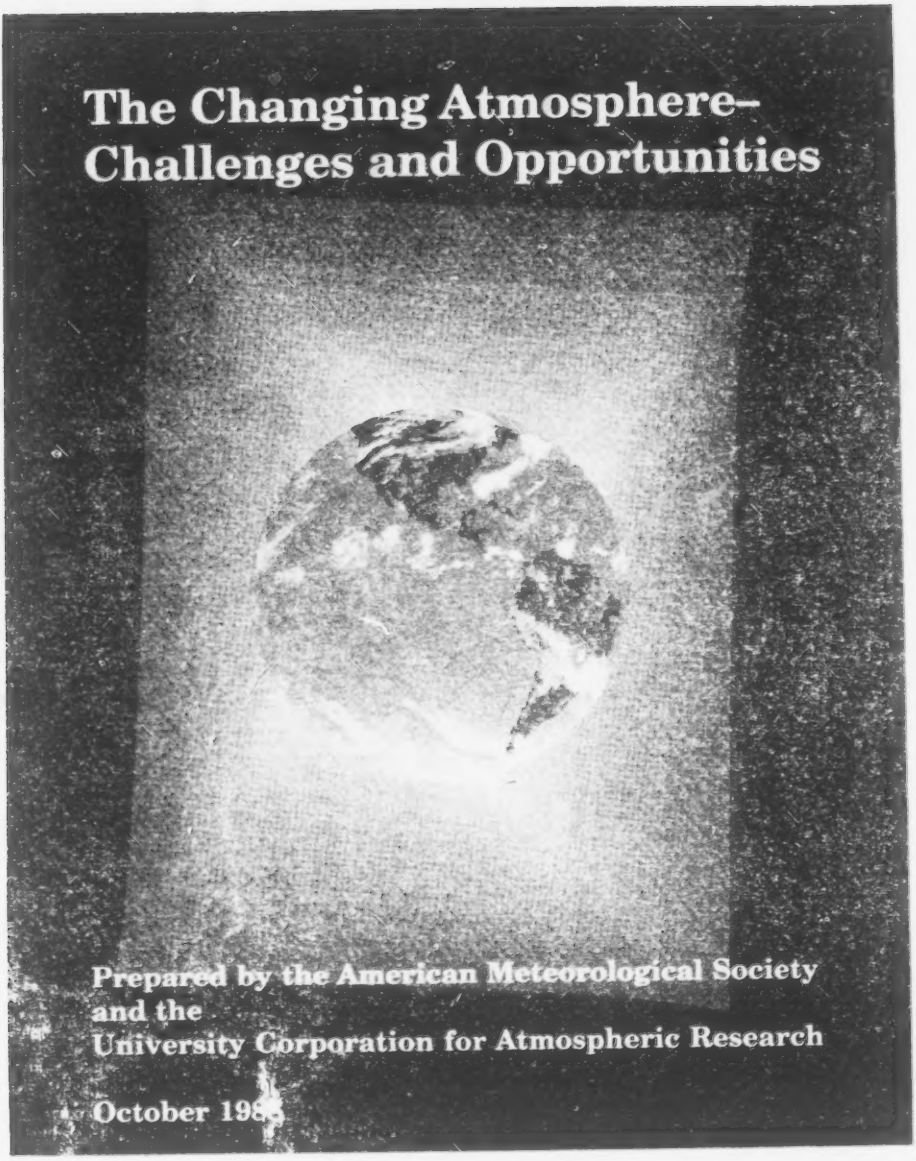
researchers and students work side by side. It must be remembered that no model simulation will ever produce a perfect forecast. But we can significantly improve prediction relative to where we are today. One of the important reasons for insisting on the close collaboration between forecasters and researchers is to determine by diagnostic testing the uncertainties in the model predictions, which vary from one weather condition to another.

STORM also includes plans for specialized field programs involving wind profilers, Doppler radars and research aircraft that will take place during the storm seasons in key parts of the United States. The first STORM field experiment is planned for the central United States during the severe storm period in the spring of 1992. The detailed case studies from these field programs will aid in diagnosing existing models and acquiring the understanding needed to improve their accuracy.

For FY 1990, $5 to $7 million are needed for the necessary startup of STORM. This amount of funding allows preparations for getting the new data streams managed, quality controlled, analyzed, archived and supplied to NMC and the research communities. The total budget for STORM amounts to only 10 to 15 percent of the cost of the technology upgrade.

I will conclude my testimony by emphasizing that the

atmospheric community has reached a surprisingly strong consensus voiced in the AMS/UCAR paper that the Weather Service upgrade with its accompanying research program STORM and the planned development of NOAA's portion of the Global Change Research are of modest cost compared to the benefits they will bring to the nation's economy, well being and scientific leadership.


The Changing Atmosphere–
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Cover: A three-channel image taken on 1 September 1985 from the Geostationary Operational Environmental Satellite, showing Hurricane Elena off the Florida Panhandle. Colors indicate moisture gradations in the atmosphere as well as the height of clouds, a technique developed at NASA Goddard Space Flight Center by A.F. Hasler and Hal Pierce. White shows the central hurricane, tropical cloud clusters, and thunderstorm tops. Subtropical highs and the region just north of the hurricane appear pink. (Photo courtesy of NASA Goddard Space Flight Center.)

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The Changing Atmosphere–Challenges and Opportunities

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Executive Summary

Important opportunities to decrease the risks to the nation from hazardous weather and global climate change and to create economic advantages through better understanding and prediction will be available to the administration that takes office in January 1989. In contrast to Mark Twain's observation that "Everybody talks about the weather, but nobody does anything about it," today there is much that is being done, and even more that must be done. The atmospheric sciences community is prepared to help carry out the needed actions.

There are two areas in which action should be taken: protecting life and property, and assessing and preparing for coming dramatic changes in climate. This report recommends specific actions and programs. It has been prepared jointly by the American Meteorological Society (AMS), a nonprofit scientific society of 10,000 members, and the University Corporation for Atmospheric Research (UCAR), a consortium of 57 universities.

Protecting Life and Property

Tornadoes, flash floods, hurricanes, blizzards, and severe thunderstorms accompanied by hail and microbursts are collectively more frequent in, and pose a greater threat to, the United States than any other nation. No part of the country is immune. Significantly improved warnings of these threatening, sometimes catastrophic events are now within reach.

Weather on a regional scale also has significant and pervasive effects on the nation's agriculture, water resources, transportation, industry, and economy. Improved weather prediction, which could provide guidance a week and longer in advance, would provide substantial economic benefits to the nation.

A key to mitigating the effects of severe weather and flood events is an improved warning system that will provide the public and industry with the weather information they need, when they need it. This can be achieved by combining new observational and information processing systems with a research program focused on understanding the development of severe storms. The nation is already moving forward with new

weather satellites, advanced surface radars, and new wind profiling systems and with information systems to collect and use the vast amounts of new data. Plans have been developed for acquiring supercomputers to prepare forecasts and carry out complementary research to realize the full benefits from the investment in the new systems and to restore the United States to leadership in weather prediction.

One of the two top-priority actions recommended by the AMS and UCAR is to complete the implementation of the existing national program to improve warnings, and to expand our capabilities in weather prediction by the acquisition of supercomputers and enhancement of a severe storms research program.

The total costs of this national program are small compared to the actual and potential losses of life and property from severe weather and flooding that occur in the United States. They are also small compared to the potential savings to the nation from more accurate and longer-range weather predictions.

Anticipating the Consequences of Climate Change

The world is increasingly aware that the global climate is changing as a result of human activities that are altering concentrations of trace gases in the atmosphere and characteristics of the earth's surface. In the next few decades, we can expect a significant global warming, an increase in sea level, and marked changes in regional and local climate. These can dramatically change agricultural productivity and human habitability in many regions of the world. The release of chlorofluorocarbons has reduced the amount of ozone in the stratosphere, with potentially disastrous effects on life on the planet, if left unchecked. Even with the vigorous effort that we must make to slow the emissions of heat-trapping gases, major climate changes are already unavoidable.

Therefore, the second top-priority action recommended by the AMS and UCAR is that the United States and other nations combine efforts to develop the observational data base, the computer models, and the understanding needed to anticipate the course of climate-related events, to estimate their impacts, and to prepare for future changes.

The United States must play a leadership role in this endeavor that is fundamental to the well-being of all peoples of the world and therefore inherently international. The investment, while substantial, is essential to ensure that the international actions to limit and adapt to the changes in climate are taken on a sound basis.

The atmosphere, oceans, sun, and biosphere are all parts of the earth's complex climate system. (Photo by Robert Bumpas, NCAR Photographics.)

Setting Firm Priorities

The United States' effort in atmospheric sciences is executed by unique partnerships of federal agencies, universities, and private sector firms. Climate change is global in nature, and therefore coordinated international action is also needed. A top priority of the new administration must be a responsible fiscal policy that diminishes federal deficits. Hence, the recommendations made here are constrained to the two highest-priority targets—taking essential actions to strengthen programs in climate and severe weather.

As with many investments made to realize the full potential of earlier investments, those described here will be repaid many times over in reduction of damage, in increased economic efficiency and productivity, and in the foresight that may allow us to cope wisely with the impacts of climate change on this nation. Letting Mark Twain's aphorism, that "nobody does anything about it," be our national policy in the face of the threat of global change could be the origin of a national and international disaster early in the next century.

1.0 Introduction

Weather and climate have had major impacts on people and civilization as long as humanity has existed on this planet. The effects of weather on the earliest primitive societies were local and relatively direct; temperature and precipitation variations affected comfort, hunting, and agriculture, while severe storms undoubtedly caused life and property losses. Climate variations, however, affected whole civilizations, stimulating mass migrations of societies as shifting climate patterns made them leave their homes to seek more hospitable surroundings.

One might think that recent improvements in technology have made modern societies less vulnerable to severe weather and variations in climate. But just the opposite is true. The importance of weather and climate has never been greater in the United States and the world. Rapidly increasing populations and the complexities of national and world economies have made societies more sensitive and more vulnerable to disruptions caused by weather phenomena such as flash floods, blizzards, severe storms, and hurricanes; and to climate variations such as droughts, excessive rainfall, and temperature extremes. The climatic changes anticipated in the next few decades are unprecedented in modern experience. To a society fixed by national boundaries and constrained by an intricate economic system based on presumptions of constancy, these changes will be of major proportions.

1.1 Present Sensitivities to Weather and Climate

A few examples illustrate the nation's high sensitivity to weather and climate:

• The safety and efficiency of our air transportation system are adversely affected by weather. Over 250 lives were lost in commercial airline crashes at New Orleans and Dallas as a result of wind shear "microbursts" associated with severe thunderstorms. Although technology has made individual aircraft less susceptible to adverse weather, the air transportation system, with its interdependent components, is overstressed and increasingly weather sensitive. Two-thirds of all flight delays and over half of all aviation fatalities are weather related.

Two-thirds of all flight delays and over half of all aviation fatalities are weather related.
(Photo by Richard Fillh ..rt.)

- Increasing and shifting populations in the United States have created the potential for weather and climate disruptions and for losses on a scale never before experienced in this country. Millions of people have been attracted to the beautiful but hurricane-prone Gulf of Mexico and Atlantic Ocean coasts. Even with more stringent building standards, a catastrophe will occur when a strong hurricane strikes one of these densely populated areas, as one inevitably will. Rising sea levels will increase this danger.

- The increase and shift of population to the sunny southwestern United States and California have created major adverse impacts on the local and regional air quality. Moreover, because increased population has led to increased needs for water, these regions are now more vulnerable than ever to prolonged drought, which would have severe and long-lasting effects on the quality of life and the economies of these regions. In the southeastern United States, the demand for water has exceeded the supply and is depleting aquifers in many locations, so even a one-year drought can have serious consequences.

- Many of the nation's most vulnerable industries and activities are concentrated in confined locations that are prone to severe weather. For them, encounters with severe weather are disastrous. For example, a single 100-mile stretch of the Texas and Louisiana coastline, particularly hurricane prone, contains more than one-third of the nation's petrochemical industry. Land subsidence, owing to collapse of depleted aquifers, will greatly increase the depth and extent of flooding expected from hurricane storm surges. Other high-risk activities in vulnerable areas include the transport of nuclear weapons by truck, and the operations of nuclear power plants, refineries, and off-shore drilling rigs.

- Space-Age activities are also vulnerable to the weather. The protective heat-absorbing tiles of the Space Shuttle can be destroyed by the impact of medium- and large-sized cloud drops. As the March 26, 1987, launch of an Atlas Centaur rocket from Cape Canaveral showed, atmospheric electricity is a serious hazard. About 48 seconds after lift-off, the rocket triggered a four-stroke lightning flash to ground. The resulting failure of the guidance system created stresses that caused the vehicle to break apart.

- The single 1982/1983 "El Niño" event, in which warm waters in the equatorial Pacific Ocean triggered atmospheric anomalies around the world, caused economic losses in excess of billions of dollars in the United States and elsewhere because of the impacts on agriculture and fishing industries. Thousands died from starvation in the associated African droughts.

• Our national security is directly affected by the weather, both in the daily operations of our land, air, and naval forces and in the development of defense systems used by these forces. Aerial operations and targeting are affected by cloud cover and winds, and command and control systems on land and at sea are impacted by weather conditions such as heavy rains, snow, or dust storms. The more complex a defense system is, the more complicated are the weather and environmental issues that must be treated in the design, development, and operation of the system.

1.2 Human Causes of Climate Change

Increasing population, technological advances, and economic demands for greater use of energy resources have not only made societies more vulnerable than ever to weather and climate, but have created for the first time a situation where humans have actually begun to *cause* important changes in weather and climate. Degradation of local environments through air pollution and of regional environments through acid rain are well-known consequences of this growth. It is becoming obvious now that environmental changes caused by human activity are not restricted to local and regional environments but also affect the weather and climate worldwide.

Because of the enormous effect they have on the earth's radiation budget, changes in the atmospheric chemical composition are a major factor in climate change. The atmosphere's composition has changed over the earth's history through natural causes. For example, biological processes over 400 million years slowly removed carbon dioxide from the atmosphere and stored it in vast reservoirs of fossil fuel. Human activity is reversing the process and changing the atmospheric composition. Not only are we burning the fossil fuel, thus returning to the atmosphere the carbon stored over millions of years, but we are also increasing atmospheric carbon dioxide by destroying millions of acres of forests, particularly those in the tropics. The result is a change in atmospheric composition that is very rapid compared to changes that have occurred naturally in the past.

Evidence of human-caused climate and sea level change is already with us. The increase in atmospheric carbon dioxide since the beginning of the industrial revolution is perhaps the best-known global consequence of human activities; but other trace gases, such as methane, have also increased. Higher concentrations of these gases have affected the atmospheric radiation budget (the "greenhouse effect"), likely contributing to a global mean surface temperature rise of about 1° Fahrenheit during the past 100 years. This warming, in turn, is probably responsible for the four-inch rise in global sea level from the melting of ice and the

Human-induced increases in some trace gases have been implicated in the sudden and large springtime decrease of ozone over the Antarctic. (Photo by Charles Smythe.)

thermal expansion of water. By the next century, we will see an acceleration of these trends, as other trace gases contribute as much as carbon dioxide, and thus more than double the overall greenhouse effect.

The human-induced increases in some of the trace gases, such as chlorofluorocarbons (CFCs), have been implicated in the sudden and large springtime decrease of ozone over the Antarctic, and in a lesser but significant decrease in ozone over the rest of the world during the entire year. The most familiar hazard associated with decreasing ozone is an expected increase in skin cancer. But a potentially far greater threat to life is the destruction and mutation of simple forms of marine and terrestrial life, upon which the food chain depends. Recognizing the global threat, more than 30 nations have taken preliminary steps, through the Montreal Protocol, to cut back on the emissions of certain chlorofluorocarbons. Even so, experts predict that the concentrations of these trace gases will continue to increase well into the next century. We need to understand the climatic variations that may be triggered by these changes in order to plan intelligently.

Human activities are also changing characteristics of the earth's surface, such as reflectivity and moisture availability. Tropical deforestation is one major impact, but changes are occurring in middle latitudes as well as a result of increasing urbanization and agricultural activities.

1.3 Impacts of Accelerating Climate Change

There is widespread agreement among atmospheric scientists that over the next 50 years—easily within the lifetime of today's schoolchildren—we will witness an accelerating change in climate of a magnitude greater than ever experienced since the beginning of human civilization. State-of-the-science climate models suggest that an average global warming of at least 3° F and perhaps 10° F is likely over the next 50 years. Although 3° F may seem small, it is larger than any sustained global warming experienced in the past 100,000 years. Furthermore, regional changes are likely to be much greater, perhaps several times as large. Should these changes occur, the impacts on our lives will be enormous. Potential impacts include:

- A significant rise in sea level—on the order of several feet—resulting in widespread shoreline erosion and inundation, especially during severe storms; loss of coastline, beaches, and wetlands and severe disruption of coastal industries; an increasing inland penetration of saline water, affecting drinking water and coastal ecosystems; and salinity intrusions in coastal freshwater aquifers.
- A higher frequency and greater intensity of hurricanes.
- Shifts in the geographic distribution of major agricultural areas and fisheries; for example, agricultural productivity may increase in Canada and the USSR and decrease in the United States.
- Shifts in the paths of large-scale low-pressure weather systems, resulting in more precipitation in some regions and less in others, and a shift in the normal location of severe storms, including tornadoes.
- Increases in the frequency and intensity of heat waves and droughts.
- Further decreases in stratospheric ozone caused by the buildup of CFCs, with possible public health and agricultural effects.

1.4 Public Policy Implications

Private and public institutions are now aware of these and other potential problems. National and international political responses are being considered, and in some cases, implemented, as in the Montreal Protocol. As another example, the Toronto Conference on the Changing Atmosphere in June 1988 brought together scientists and policy makers from 48 countries, who recommended a 20% reduction in carbon dioxide emissions by 2005 and a complete worldwide ban on the use of CFCs.

It is important that scientists and policy makers work together in this way to develop sound policies based on the best possible scientific information, and to avoid the dangers of overreacting to, as well as ignoring, issues associated with weather and climate. Policies must take into account the present uncertainties associated with scientific understanding of weather and climate, as well as deal with the wide range of possible scenarios.

This discussion has so far emphasized the hazards associated with weather and climate. The ability to forecast severe weather and to provide scientifically based estimates of future climate change can certainly be used to lessen the deleterious impacts of the atmosphere. Moreover, improvements in understanding and predictive ability can also be used in a positive way to create economic advantages. For example, even small improvements in wind forecasts will produce enormous savings in aircraft fuel, thus increasing the efficiency of the national air transportation industry and defense aviation. Better rainfall forecasts can increase efficiency in applying pesticides and fertilizers, and in irrigation practices. Weekly and monthly outlooks for heat waves, droughts, and prolonged cold periods can help to make regional distributions of energy and water more efficient. Reliable estimates of changes in sea level and regional precipitation and temperature can be used to guide the long-range development of agricultural, hydrological, and urban plans, and strengthen the economy and security of the nation as a whole. These steps can promote conservation of natural resources and increased efficiency of the entire United States economy.

The rest of this document discusses the opportunities in weather and climate operations and research that will benefit the people of every part of the United States. These programs will help protect life and property from weather phenomena, enhance our national security, make the United States more competitive in the global economy, and, with the cooperation of other nations, allow for the development of effective policies to cope with the large changes in climate expected over the next few decades.

For convenience, we classify the required research and operational programs as related closely either to "weather," which includes atmospheric events with lifetimes of minutes to a few weeks, or to "climate," which includes events lasting months to decades and beyond. It is important to recognize that weather and climate processes are closely related: Therefore, improved understanding and prediction of weather will also improve our understanding and ability to predict climate, and vice versa.

2.0 Protecting Life and Property through Improved Weather Prediction

Scientific understanding of the atmosphere and the ability to forecast the large-scale evolution of the weather have increased dramatically over the past two decades. Today, general forecasts of temperature and precipitation are as accurate at 48 hours as they were at 24 hours a generation ago. Significant skill exists today in six-day forecasts, where little existed ten years ago. This progress has been possible because of the major investments made by the nations of the world in support of meteorological operations and research. These investments have improved global observations, primarily by weather satellites, and have provided supercomputers to process the data and run sophisticated forecast models of the global atmosphere. However, these technological advances by themselves would have been fruitless without the better scientific understanding that has resulted from sustained international operational and research programs.

Much of the progress was initiated by two highly successful international programs that grew out of a speech by President Kennedy to the United Nations in 1961. The World Meteorological Organization (WMO) of the United Nations developed the World Weather Watch, which coordinates the collection and exchange of meteorological data from all nations. These data were used in a complementary research effort, the Global Atmospheric Research Program, to improve our understanding and ability to predict day-to-day changes in large-scale weather patterns. The research involved a series of focused international field experiments coordinated by the intergovernmental agency WMO and the nongovernmental scientific agency the International Council of Scientific Unions (ICSU).

In spite of the resulting improvements in forecasts of large-scale weather patterns beyond one day, the weather events that are usually most significant for society—smaller-scale, rapidly developing events such as flash floods, thunderstorms, hail, tornadoes, wind shear, hurricanes, and heavy snow—are neither understood, observed, nor predicted as well as they could be.

2.1 Forecasts and Warnings of Severe Weather

The United States experiences more severe local storms and flooding than any other nation in the world. Eighty-five percent of the presidentially declared disasters result from severe weather events—the hurricanes that batter the Gulf and East coasts each year; the 1,000 tornadoes annually, striking most frequently in the Midwest and southern states; the flash floods and river floods that occur in all states but especially in the Appalachians, New England, and the mountainous West; and the blizzards that occasionally paralyze many northern cities and states.

Because of their small size and short duration, most severe weather phenomena occur between our observing stations and thus escape systematic measurement and early detection. Research has demonstrated that these small-scale, rapidly developing weather events can be detected and forecast with much greater accuracy, using advanced observational and computational technologies, and in advanced models of severe weather phenomena.

Building on these advances, the National Weather Service can now improve severe weather and flood warnings by introducing new observation and information systems across the United States. By doing so, we will, for the first time, provide weather observations on a sufficiently refined space and time scale to detect these events at an early stage, and, even more importantly, we will be able to predict their development and motion in a timely manner.

The technology for this enhancement of the nation's weather warning system is already in various stages of development and implementation. A determined effort, with adequate funding, is now required to bring the program into full operation.

The technological systems fall into two categories:

(1) Detection and Observing Systems—Geostationary and polar orbiting meteorological satellites; advanced Doppler radars, automated surface observing stations, and automatic temperature, moisture, and wind profiling systems.

(2) Data Processing and Communication Systems—Interactive computer, display, and storage systems for all weather stations and large central supercomputing systems located at operational and research centers.

These enhanced detection and observing systems will revolutionize our ability to locate and determine the intensity of all severe storms. The next generation of geostationary satellites (GOES) will observe storms and give a detailed topside view of the weather systems throughout the United States and adjacent waters. The new advanced radar (NEXRAD),

The United States experiences more severe local storms and flooding than any other nation in the world. (Photo by Charles Semmer, NCAR Photographics.)

a joint effort of the departments of Commerce, Defense, and Transportation, will provide for the first time the ability to see "inside" intense storms. This will let us detect the amount of rain falling, information that is essential for flash flood warnings, and to measure the wind patterns that are precursors of tornadoes. The Automated Surface Observing Station (ASOS), a joint effort of the Commerce and Transportation departments, will be located at airports throughout the country and will provide the continuous, 24-hour observations necessary for aircraft operations and for forecasting without the large investment required by current labor-intensive systems. The wind profiling system will provide the nearly continuous wind observations from the surface to jet aircraft altitudes that are important to predict the onset of severe weather and for efficient aircraft operations.

The data processing and communications systems contribute a vital part of the overall warning process. The amount of data produced by the detection systems, especially satellites and radars, would overwhelm forecasters unless they have the capability to convert the raw data into meaningful information needed to prepare and disseminate the warnings and forecasts. The Advanced Weather Interactive Processing System (AWIPS) is being designed to collect these data, convert them to information, and communicate this information to the forecaster.

Weather forecasts for periods longer than a few hours require combining meteorological information with meteorological theory using numerical models of the atmosphere. In the United States, this vital step is performed on powerful computers at the National Meteorological Center (NMC). The military establishments operate similar computer centers for their own specific needs. The final critical link required in the technological program is to replace the present computers at NMC with more modern and more powerful supercomputers. Forecast skill using these models is directly related to the power of the available computers. The United States has not been sufficiently aggressive in providing the necessary funds for these computers. As a result, the European Center for Medium Range Weather Forecasts, which is using the most advanced American-made computer, produces more accurate forecasts than we do in the United States.

These improvements in measurement systems and computers will enable a quantum advance in our capability to observe and predict weather and climate. However, the full potential benefits of these complex systems will come only with the development and application of new concepts and understanding through extensive participation of the research community, including research laboratories and the university community in the overall national effort.

The meteorological community has identified and planned a program of severe storm research as the most important next step in improving forecasts and warnings of severe weather and flooding. This program is

called STORM (STormscale Operational and Research Meteorology). It will engage the research community in the development and use of the new observational and modeling capabilities. To ensure the transfer of research results into improved operations, the program includes experimental forecast centers where operational forecasters and researchers work side by side. STORM also includes plans for specialized field programs, involving Doppler radars and research aircraft, that will take place during the storm seasons in key parts of the United States. The first STORM field experiment is planned for the central United States during the severe storm period in the spring of 1992.

While programs for most of the operational systems hardware are being funded and must be completed, an additional 10–15% for the high payoff STORM research program should be added to the national effort. If prolonged further, this funding shortfall could lead to a serious loss of potential benefits to the nation's weather warning, forecast, and training capability. The delay will also result in a missed opportunity to collaborate and capitalize on the research and forecast capabilities of other nations such as Japan and the European countries.

2.2 Serving the Economy—Medium- and Long-Range Forecasting

Weather forecasts for periods of a week, and probabilistic outlooks on temperature and precipitation anomalies for a month in advance, can increase the productivity and efficiency of industry and commerce. Agriculture is especially sensitive to weather, experiencing losses of more than $20 billion each year. As requirements for limited water resources increase, the use of weather and climate information to improve water management will be vital to regional economies. Efficiencies in the use and distribution of energy are also weather sensitive. An increase of only a few percentage points in efficiency of energy operations would result in a several-billion-dollar improvement in our overall economy.

Remarkable scientific advances have been made in weather forecasting over the past ten years. Because of the worldwide Global Atmospheric Research Program initiative, useful six-day forecasts are now produced routinely. With a concerted national effort over the next decade, the useful range of day-to-day forecasts can be extended to ten days, and significant enhancements of the accuracy of monthly outlooks can be achieved. Seasonal forecasting should also improve through greater understanding of ocean-atmosphere interactions, such as El Niño.

To realize the potential of today's science and technology requires continuation of the meteorological polar orbiting satellites, a more aggressive effort in furthering scientific understanding of the atmosphere-ocean-land-ice system, and the availability of the most powerful supercomputers at major atmospheric research centers and at the National Meteorological Center.

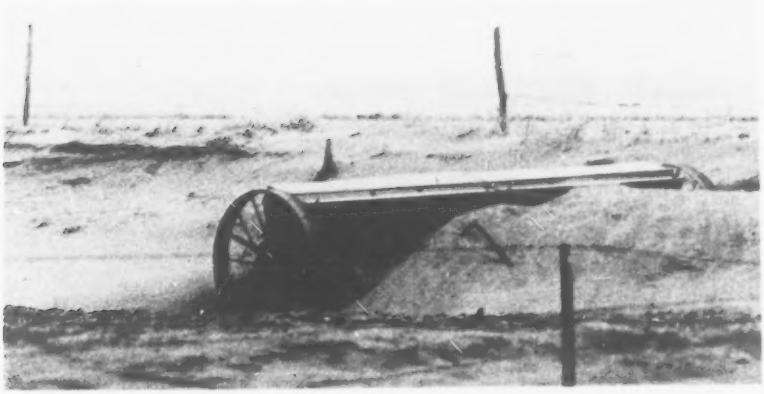
3.0 Anticipating and Adapting to Climate Change

There is a growing scientific concern that we are already embarked upon a path of climate change of unprecedented magnitude that will occur within our lifetimes—a climate change caused largely by ourselves.

3.1 Expected Climate Change in the Next Few Decades

It is highly probable that a global warming of unprecedented magnitude is now in store, following inexorably the irreversible changes we have made in the chemistry of the atmosphere through fossil fuel burning, CFC use, and land-use practices throughout the world. What is uncertain is when this human-induced warming trend will loom above the natural variability that has always characterized climate. It may be already with us: the average surface temperature of the earth has been slowly, though irregularly, rising for at least the last 100 years. As a result the planet is now warmer than it has been in all the years since quantitative temperature records began. We also know that during the past 100 years the amounts of carbon dioxide, methane, and other greenhouse gases in the atmosphere have been climbing at an ever-increasing rate, lending credence to the conclusion that human-induced changes are already evident. The several currently oversimplified computer-based climate models, owing to their different assumptions (mainly regarding the ocean), predict different magnitudes and regional distributions of global warming. They all agree, however, that we must expect a continued climate warming, driven by the long-lived greenhouse gases now resident in the air, and by the increasing amounts of these gases that humanity continues to pour into the atmosphere.

It is highly probable that the world we bequeath to our children and to their children will be climatically unlike any that the earth has experienced in the last 100,000 years. Present evidence indicates that our heirs will experience higher average temperatures and higher sea level; different distributions and intensities of rainfall and droughts; and a different pattern of agriculturally productive regions. The 1988 summer's American drought, whether or not it is related to greenhouse warming, indicates the vulnerability of our agricultural system to relatively minor climate fluctuations, and it is typical of what can be expected in the future.



The 1988 summer's American drought, whether or not it is related to greenhouse warming, indicates the vulnerability of our agricultural system to relatively minor climate fluctuations, and it is typical of what can be expected in the future. (Photo by Robert Bumpas, NCAR Photographics.)

It takes little imagination to recognize that climatic changes of this magnitude will bring with it changes in the economies and well-being of all countries and will result in shifts in the balance of world trade and of world power. It is essential that policy makers and scientists work closely together to upgrade our models and observations to increase understanding and ability to predict impending climate changes, including associated regional changes, whether and how climate change can be slowed, and how our own country should adjust to the inevitable global changes.

3.2 Components of a Coordinated Climate Change Program

We need to mobilize the talents of the best scientists and our best scientific institutions to improve our understanding of global climate and to sharpen predictions of climate changes and their implications. We must include agricultural scientists, foresters, economists, and planners at the outset, to ensure that the research of physical scientists will produce the information needed by the policy-making community.

The changes that are anticipated are global, and the challenge of meeting them is now recognized by leading scientists in every country around the world. Multidisciplinary research programs to address the problems of global change are now being organized both nationally and internationally, to commence in earnest in the early 1990s. These planned programs will in effect put the earth in intensive care, by monitoring the

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physical, chemical, and biological vital signs of the planet while at the same time pressing forward our understanding of the earth as a system. In this country an organizational structure is in place that will tie scientific guidance from the National Academy of Sciences to an interagency infrastructure through the Office of Science and Technology Policy to coordinate the efforts of the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), and six other United States government agencies in a national program to study global aspects of environmental and social changes driven by climate change—a program referred to as the Global Change Program. An unprecedented team of scientists and policy makers is being called into action. What is still needed is the announced commitment of this nation to assume a role of leadership.

The climate system is exceedingly complex, consisting of multiple atmospheric, oceanic, biospheric, and cryospheric processes and interactions. A balanced climate research program must therefore involve programs in solar physics, atmospheric chemistry and dynamics, oceanography, and the interactions of the biosphere, cryosphere, and land surface with the atmosphere and oceans.

The required research program is based on two major components—a comprehensive global observational program to document the extent and rate of global and regional climate change, and improvement and verification of computer models of climate to convert these observations into reliable predictions.

Because of the global nature of the climate system and the necessity to understand its multiple processes in interaction, many of the needed measurements must be made from space. An approach to understanding the global system has been developed by NASA through its Earth System Sciences Committee. Central to this plan is its Earth Observing Systems (Eos) program to study the earth system. Eos involves three new space platforms in polar orbit to measure temperature, winds, precipitation, moisture, chemical species, and sea-surface characteristics, including temperature and color (which is related to biological activity). This satellite system will be created in cooperation with Japan and several European countries, and will replace our present weather satellites.

Despite the unprecedented power of Eos, other complementary missions will be essential. For example, rainfall, with its associated release of heat, is one of the most important components in the hydrological cycle, and tropical rain variability is a crucial link associated with the far-reaching effects of El Niño events. Yet it is presently not possible to obtain adequate precipitation information over the oceans or from most of the Third World nations. It is feasible to obtain a tropical precipitation climatology from space, and NASA has planned a Tropical Rainfall Measuring Mission as early as 1994 to do that.

Daily global ozone maps are another important example of essential measurements that can only be obtained from a spaceborne sensor. NASA is planning a series of inexpensive "Earth Explorers," in some cases with international collaboration, which can be launched in the early to mid-1990s.

Many other types of data on the components of the earth system and their interfaces must be taken and made widely available. Accomplishment of this difficult, imperative goal must involve an international community and international organization. The structure for coordinating research on the physical aspects of climate is provided by the World Climate Research Program (WCRP), whereas a research program on the biological interfaces to the climate system is currently being developed by an ICSU Special Committee for the International Geosphere-Biosphere Program (IGBP).

The plan for the United States' contribution to the IGBP, which has been developed by the National Research Council's Committee on Global Change, focuses especially on the interactions between biological processes and the physical climate system. The atmospheric sciences are at the center of this program as well and have provided national and international leadership for the IGBP.

The United States research community participates in several large research programs under the auspices of the WCRP. This participation is coordinated through the National Climate Program Office. These several programs are complementary, and, together, will lead to the improved understanding and observations that are needed. The World Ocean Circulation Experiment is developing the observational and modeling capability for the oceans. The Tropical Ocean–Global Atmosphere Program is studying the coupling between the tropical oceans and atmosphere over periods of a few years, in order to understand and predict the El Niño–Southern Oscillation climate anomalies that have major impacts on global weather systems. The International Satellite Cloud Climatology Project is a multidisciplinary research program to study the roles that clouds play in climate. Currently in a planning phase is a Global Energy and Water Experiment intended to develop an improved knowledge of the global hydrological cycle and energy fluxes, both through global measurements and by simulation with climate models. The atmospheric chemistry aspects of the climate system are addressed by the Global Tropospheric Chemistry Program, which has the goals of understanding basic chemical cycles in the troposphere and predicting their response to natural and human perturbations. The International Satellite Land-Surface Climatology Project is investigating the effect of variations in land surface characteristics on regional and global climates. NSF, NASA, and NOAA are major supporters of these internationally coordinated programs and this support should continue.

4.0 The Partnership in Atmospheric Science

Atmospheric science is characterized by an array of partnerships at the local, national, and international levels. These mutually beneficial ties link the federal agencies, the universities, professional societies, the private sector, and volunteer American citizens, as well as international agencies. It is extremely important that these interdependent relationships be understood in the formulation of policy because of the many ways in which they interact.

At the local level in the United States, the severe weather and flood warning system relies heavily on an extensive system of "spotters" who observe and report severe weather to the National Weather Service and civilian authorities. These individuals and groups are frequently ham radio operators, police, farmers, and other concerned American citizens. There are 150,000 individuals throughout the United States who support the National Weather Service in this way on a volunteer basis. The climate of the United States is being recorded by 11,000 cooperative observers. Without this group of volunteers, much of the detail of the climate of this country would not be known.

Weather services for the people of the United States are provided through the joint efforts of the National Weather Service and a group of private meteorological services. The government provides the warnings of severe weather and floods as well as public weather forecasts; the private meteorologists provide the specific services required by industry. Radio and television are the primary ways of disseminating warnings and forecasts to the public, and are a key public/private partnership. The observational systems and the central computing centers, which also support private meteorologists, are provided primarily by the National Weather Service in cooperation with the departments of Defense and Transportation.

Another key partnership is among the universities (which educate and train new scientists, engineers, and technicians, and perform much of the basic research), the federal weather services, and research laboratories (particularly those in NOAA, NASA, and the NSF's National Center for Atmospheric Research). The tie between basic research and operations in the field of meteorology is more direct than that of virtually any other field.

The cliche "the atmosphere knows no national boundaries" is a fundamental truth, and from it stems an international need for cooperation. Here, an Indian monsoon disrupts village life. (Photo by Robert Schware.)

At the international level the partnerships are also intense and uniquely different from those in any other activity. The cliche "the atmosphere knows no national boundaries" is a fundamental truth, and from it stems an international need for cooperation that transcends politics. For over 100 years the nations of the world have exchanged meteorological data freely and at no cost to each other. Coordinated procedures in the way weather observations are taken—what elements to measure, at what time—are followed by all countries. These data are sent over internationally agreed-to communication systems that are coordinated by the WMO. Without these observations, skillful forecasts for more than two or three days would not be possible for the United States. This arrangement for the free exchange of data must be preserved.

That our knowledge of the atmosphere can be advanced through internationally coordinated efforts has been demonstrated by the World Weather Program. The climate change issue is global by its very nature. It is therefore obvious that internationally coordinated action is essential to understand the climatic system of Planet Earth and adapt to or limit the effects of climatic change.

5.0 Meeting the Challenge– Responding to Opportunity

Understanding and predicting weather and climate have never been more important to the people of the nation and the world. Major advances in observational and computational technology, in understanding, and in prediction are within reach. While the resources required to make optimal progress in advancing weather prediction and warning systems to protect life and property and in meeting the complex challenges associated with climate change are significant, they are small compared to the payoff in the savings of lives and property, and in helping society adjust to climate change.

We have summarized in this document the challenges and opportunities the atmosphere presents to the administration that will take office in January 1989. We have described what, in the national interest, must be accomplished in weather observation and prediction and in understanding and predicting the course of global climate change.

The discussion focused on the new scientific concepts that foretell significant advances—new ideas that will dramatically change the weather business. It considered the technology available to effect these new ideas—weather radars, atmospheric profilers, supercomputers, and extensive spaceborne measurement systems. It described the existing partnership between the government, the universities, and the private sector that produces and applies new knowledge about the atmosphere.

The people, the new technology, and the new ideas at hand combine to offer unprecedented advances in weather prediction and in understanding climate change. A commitment of increased, sustained federal support will allow these assets to be used to benefit the American people and will restore American leadership in atmospheric science.

But much more than national leadership is now at stake. The activities of the burgeoning peoples of the world are beginning to change the world itself. America and all other nations must begin to examine together the implications of global change, to study scenarios of the future, and to contemplate policies that will mitigate our rapidly increasing modification of the global environment. These deliberations must be based on sound scientific conclusions that are themselves derived from

careful, long-term measurements and on prediction models whose accuracy has been thoroughly tested and verified. The new administration thus has the opportunity and the responsibility to make a firm commitment to understanding global change, and to lead the world in thinking seriously about the future of the planet.

Mr. SCHEUER. Dr. Simpson, thank you very, very much.

Mr. Quadros.

Mr. QUADROS. Thank you, Mr. Chairman.

I am the President of the National Weather Service Employees Organization. I also work as a meteorologist in the San Francisco Forecast Office.

Regarding the proposed NOAA budget, our organization is concerned about protecting the public safety and protecting the long-run cost effectiveness for the taxpayer.

Mr. Chairman, our organization believes that NOAA management's dichotomy of saying one thing and doing another should be reviewed in detail by the Congress. It jeopardizes public safety and puts unjustified trust into unproven and expensive new technologies.

The first point I want to make is that NOAA management has clearly disguised reductions of staff and the hours of operation for weather forecast office in its fiscal year 1990 budget submission to the Congress. As a result of not filling job vacancies, many offices are being closed at night and on weekends. Weather systems which impact the American public, of course, have no time limits. They're a 24 hour per day phenomena. This is something that was not touched on completely earlier with the closing of stations. We're also concerned with the reduction of hours, midnight and evening shifts in some cases.

Mr. SCHEUER. Down in North Carolina last fall, were there costs and fatalities flowing from the fact of a weather—a National Weather Service station being closed evenings, weekends, holidays, or did it come predominantly from inadequate, obsolete technology?

Mr. QUADROS. It's my understanding that technology failure was largely the cause there. We're concerned, though, that in other parts of the country, particularly the Midwest, which, of course, is the most prone area to severe weather this time of the year, there are a number of stations that are already closed at night in this very important area.

Mr. SCHEUER. Were they able—Does history prove that when a station is scheduled to be closed at night, that if indicates are from—if indications are that some catastrophic weather is approaching, that they can make emergency provisions to man the weather stations, whether it's an evening, a weekend or a holiday?

Mr. QUADROS. Yes, there are provisions that the staff that would be on duty during the day or evening shift would be able to stay over into the midnight shift. However, that's only if they recognize the potential correctly and anticipate that there could be something that particular night. The science is not perfect and situations could develop where just by somebody not being there something could be—

Mr. SCHEUER. Yeah. Please continue.

Mr. QUADROS. As Congressman Morrison already mentioned, the reductions in the number of employees in the western region—I won't go into the numbers there—these decreases have taken place due to contracting out. Other decreases have resulted from reduced National Weather Service involvement in air pollution forecasting,

aviation forecasting, marine forecasting, satellite data interpretation.

Even though Congress has not allowed the wholesale elimination of fruit frost, agricultural and fire weather forecasts, staffing has been reduced. Even though Congress did not allow reduction of the number of regional headquarters, NOAA went ahead anyway with the consolidation of functions at the area service centers. Even though Congress did not allow reductions of meteorological technicians or forecasters, an overzealous regional director reduced staffing anyway.

Naturally occurring vacancies due to retirement, transfer and the like, went unfilled for long periods of time. In a little more than eight years, there has been a 35 percent staffing reduction in the western region, and at the present time one out of every eight positions is being held vacant. I have no reason to suspect that this is not the case in other regions as well.

Our main point is—enough reductions. NOAA management has gutted the National Weather Service with the excuse that new technology could replace people. The American public deserves adequate meteorological coverage with proven technology, and until the new systems are proven, there should be no further reductions in staff. In fact, there should be an increase in the level of staff up to the number of positions already authorized by Congress.

The second point I want to make is about the next generation weather radar, called NEXRAD, and the Automated Surface Observation System, called ASOS. Our organization believes these systems are not proven and it is wrong for NOAA to tell the Congress, this subcommittee and the American people that these expensive new technologies will be the savior of the National Weather Service's mission and an adequate replacement for the National Weather Service work force.

We're not saying that NEXRAD is bad technology. We're saying that the system may have been oversold in its presentation to you. We have serious doubts about the coverage of the system, extending to the areas indicated in the NOAA plans.

Mr. Chairman, I ask permission to include our fact sheet on NEXRAD and ASOS in the record of this hearing, which is attached to my testimony.

Mr. SCHEUER. There being no objection, so ordered.

Mr. QUADROS. NEXRAD has never really been tested outside the contractor's facility in Connecticut and Pennsylvania. During a test conducted in 1986, NEXRAD failed 138 times due to unknown causes. During 1987 tests, NEXRAD's transmitter failed five times in 40 days, as opposed to the manufacturer's predicted failure rate of once in 170 days. The first test using NEXRAD in a real-life forecasting situation began in March of this year in Norman, OK, and will continue through the summer.

ASOS has been tested more thoroughly than NEXRAD, but the results of these tests demonstrate that fully automated weather observations are not now technologically feasible.

The National Weather Service internal report, which our organization obtained through FOIA, revealed that nearly every ASOS sensor failed in some way during a pilot project conducted in Kansas. ASOS was incapable of detecting cloud height cover over

about 10,000 feet, and the cloud height indicator occasionally failed to detect stationary or widely scattered cumulus clouds. The cloud height indicated reported false readings during mild precipitation and failed completely during heavy precipitation. The ASOS laser weather indicator failed to adequately discriminate among rain, snow, drizzle, hail, sleet, and mixed precipitation. Lightning and freezing rain were detected with only partial success. The internal report concluded that ASOS did not demonstrate adequate present weather detection capability.

Until NEXRAD and ASOS have been tested successfully, the Congress should not commit itself to full-scale procurement of this new technology at the expense of current staff and services.

The third point I want to make is about inconsistent statements to Congress. In its fiscal year 1990 budget submission to Congress, NOAA said, "It will be necessary to close 70 stations." When Commerce Secretary Mosbacher recently testified before Congress on the budget, he promised that none of the 197 Weather Service offices will be closed this fiscal year. As we have heard testimony earlier, the closing of these offices is not slated to take place. We worry, more importantly, about the closure at other times of the day or part of the day.

The fourth point I want to make is that this administration continues to advocate for the privatization of the National Weather Service. This, we believe, is a detriment to public safety. In the President's fiscal year 1990 budget, the administration identifies the Weather Service as one of the 1990 privatization initiatives, indicating that the Government will issue a policy statement clarifying those weather forecasting functions to be performed by NWS and those to be performed by the private sector. Our organization has taken a firm stance against privatization, and the Congress should prevent this from happening.

The fifth point I want to make is whether the intent of Congress is being violated. Section 208 of Public Law 100-685 regarding NOAA authorization states, "The Secretary of Commerce may not close, consolidate, automate, or relocate any such office unless the Secretary has certified to your full committee that such action will not result in degradation of weather services provided to the affected area."

We believe that the NOAA reductions in staff and partial closings or reductions in the hours of operation for National Weather Service offices are the same as closings included in Public Law 100-685 and thus violate the spirit, if not the letter, of the law.

In conclusion, our organization applauds the continued support provided by the subcommittee to maintain adequate funding for the various services and positions needed to fulfill the National Weather Service public safety role. Your courage and foresight in this time of budget constraint is appreciated by the Federal employees of the National Weather Service.

If the Congress took the occasion of the National Weather Service modernization plan to hold a series of hearings on the National Weather Service, including its role in NOAA or as a separate agency, then perhaps the Congress and the American public could receive the true picture of what is really at stake.

For example, the modernization plan would redefine and change the mission statement of the National Weather Service in a way in which we feel is wrong. Our organization pledges to do all it can to assist you and your colleagues in such an endeavor.

Thank you.

[The prepared statement of Mr. Quadros follows:]

STATEMENT OF

JOHN QUADROS, PRESIDENT

NATIONAL WEATHER SERVICE EMPLOYEES ORGANIZATION

SUBMITTED TO THE

SUBCOMMITTEE ON NATURAL RESOURCES,

AGRICULTURE RESEARCH AND ENVIRONMENT

OF THE

HOUSE SCIENCE, SPACE AND TECHNOLOGY COMMITTEE

ON

APRIL 4, 1989

Mr. Chairman and members of the Subcommittee, my name is John Quadros, and I am President of the National Weather Service Employees Organization. I work as a meteorologist in the Weather Service Forecast Office located near San Francisco, California.

Our organization is a union which represents employees of the National Weather Service and the National Environmental Satellite Data and Information Service, both within the National Oceanic and Atmospheric Administration (NOAA). We have a strong interest in the NOAA FY 1990 budget and have first-hand knowledge of the likely impact which this budget will have on the general public.

Our organization has always tried to focus on two themes regarding our analysis and comments on the Administration's proposed NOAA budget, and these are protecting the public safety and protecting the long run cost-effectiveness for the taxpayer.

Mr. Chairman, our organization believes that NOAA management's dichotomy of saying one thing and doing another should be reviewed in detail by the Congress. It jeopardizes pubic safety, and puts unjustified trust into unproven and expensive new technologies.

I. "DISGUISED" REDUCTIONS

NOAA management has cleverly disguised reductions of staff, and the hours of operations for weather forecast offices, in its Fiscal Year 1990 Budget submission to the Congress. For example, the National Weather Service admits that it has 254 full-time employees, "on board but lacks sufficient resources to fund their activites," (see page NOAA-21 of the NOAA Budget Justification book).

As a result of not filling vacancies that occur when current employees retire or transfer, there is insufficent staff to continue 24-hour-a-day operations at many of these offices, and they are being closed at night or on weekends. The hours of operation at weather stations at Lexington, KY; Augusta, GA; Austin, TX; Wichita Falls, TX; Helena, MT; Norfolk, NE; Rockford, IL; and Sioux City, IA, already have been or soon will be reduced. More stations will be added to this list as staff vacancies occur and are left unfilled. Weather systems which impact the American public have no time limits. They are 24-hour per day phenomena.

Let me illustrate these disguised reductions and the impact they have had on current operations in our Western Region.

In 1981 the number of full time employees in the Western Region was 900. By the end of President Reagan's first term, this number had been reduced to 703. As of March 11, 1989 it has been further reduced to 581. Of these 581 positions, 69 are currently vacant. Other regions in the NWS are similar.

How did this happen? Virtually no one was fired. Decreases have taken place due to contracting out of upper air and surface observation sites. Other decreases have resulted from reduced NWS involvement in air pollution forecasting and centralization of aviation forecasting. Currently, marine forecast and satellite interpretation positions are being eliminated. Still further changes have occurred at the regional headquarters with consolidation of functions at NOAA's Area Service Center in Seattle. To a lesser extent there have been reductions in fruit-frost, agriculture and fire weather forecast programs.

Because Congress has not allowed the wholesale elimination of fruit-frost, agriculture and fire weather forecasts, these programs remain, although staffing has been reduced. Congress did not allow a reduction of the number of regional headquarters, but NOAA went ahead anyway with the consolidation of functions at the Area Service Centers. Congress did not allow reductions of meteorological technicians ("met techs") at Weather Service Offices, or forecasters at Weather Services Forecast Offices, but an overzealous Regional Director reduced staffing anyway in the Western Region. Where staffing could not be reduced permanently, naturally occurring vacancies (due to retirement, transfer, etc.) went unfilled for long periods of time. In a little more than 8

years there has been a 35% staffing reduction in the Western Region, and at the present time one out of every eight positions is being held vacant.

During the Nixon Administration, the Congress objected, and rightfully so, to the President's tactic of impoundment of appropriated funds. NOAA management has embarked on the same path as President Nixon. It was wrong then, and it is wrong now, especially when lives are at stake.

Our main point is: "enough reductions!" NOAA management has gutted the National Weather Service without any new technology in place. The National Weather Service modernization plan is not driven by adequate meteorological coverage to be provided by the new technology, but rather by further reductions in staff. The American public deserves adequate coverage with proven technology, and this can only occur with not only no further reductions, but also an increase in the level of staff up to the number of positions already authorized.

II. NEXRAD AND ASOS ARE UNPROVEN TECHNOLOGIES

The Department of Commerce has requested in its Fiscal Year 1990 Budget an increase of $45 million; from $41.4 in Fiscal Year 1989 to $86.2 million in Fiscal Year 1990, for full scale production of the next generation weather radar (NEXRAD). In the National Weather Service modernization plan submitted to Congress earlier this month, it stated on page 3 that the:

> "...nation needs to put the new meteorological science into practice. This will require training personnel and the deployment of proven, new observational, information processing and communications technologies."

Our organization believes these systems are not proven and it is wrong for NOAA to tell the Congress, this Subcommitee, and the American people, that these expensive new technologies will be the saviour of the National Weather Service's mission and an adequate replacement for the National Weather Service work force.

Mr. Chairman, I ask your permission to include our fact sheet on NEXRAD and ASOS in the record of this hearing.

NEXRAD has never been tested outside the contractor's facilities in Connecticut and Pennsylvania. During a test conducted in 1986, NEXRAD failed 138 times due to unknown causes. During 1987 tests, NEXRAD's transmitter failed 5 times in 40 days, as opposed to the manufacturer's predicted failure rate of once in 170 days. The first test using NEXRAD in a real-life forecasting situation began in March, 1989 in Norman, Oklahoma, and will continue through this summer.

The "human" vs "machine" argument was clearly enunciated in the National Weather Service modernization Plan on page 7 as follows:

> "... key trade-offs i.. the restructuring process exist between human capabilities, costs and programmatic, scientific, and technological opportunities."

The 1990 budget also proposes an increase of $2.5 million, from $6.2 million in Fiscal Year 1989 to $8.7 million in Fiscal year 1990, for production of an Automated Surface Observation System (ASOS), which will ostensibly automate the weather observations taken hourly by NWS employees at 250 locations. ASOS has been tested more thoroughly than NEXRAD, but the results of these tests demonstrate that fully automated weather observations are not now technologically feasible.

A National Weather Service internal report, which our organization obtained through the Freedom of Information Act, revealed that nearly every ASOS sensor failed in some way during a pilot project conducted in Kansas. ASOS was incapable of detecting cloud height cover above 10,000 feet, and the cloud height indicator occasionally failed to detect stationary or widely scattered cumulus clouds. The cloud height indicator reported false readings during mild precipitation and failed completely during heavy precipitation. The ASOS laser weather indicator failed to adequately discriminate among rain, snow, drizzle, hail, sleet, and mixed precipitation. Lighting and freezing rain were detected with only partial success. The internal report concluded that ASOS "did not demonstrate adequate present weather detection capability."

Ironically, the 1990 budget seeks to save $1 million by delaying until 1991 a planned demonstration project that will further test NEXRAD, ASOS, and associated National Weather Service restructuring. Until NEXRAD and ASOS have been tested successfully, the Congress should not commit itself to full-scale

procurement of this new technology at the expense of current staff and services.

III. INCONSISTENT STATEMENTS TO CONGRESS

In its Fiscal Year 1990 Budget submission to Congress (see page NOAA 174) NOAA, said that a:

> "... decrease of 473 positions and $14.8 million from the base program is proposed because of budget constraints. In order to accomodate this FY 1990 reduction and to absorb three-quarters of the FY '89 pay raise, it will be necessary to close 70 stations."

When Commerce Secretary Robert Mosbacher recently testified before the Congress on the NOAA budget, he promised that none of the 197 weather service offices will be closed "this fiscal year." However, the Secretary's statement is misleading, because press reports after the Secretary's statement to the Congress indicated that the National Weather Service still plans to close over 150 offices and eliminate 800 employees in the next few years. Mr. Chairman, I ask your permission to enter these press reports into the record of this hearing.

As if to add more confusion to the issue, the Department of Commerce also indicated in it's budget submission (see page NOAA 157) that 585 positions would be decreased in fiscal year 1990. What are we to believe? Is the Congress getting the straight story from the Administration?

IV. THE PHILOSOPHY OF PRIVATIZING THE NWS HAS NOT CHANGED

This Administration continues to advocate for the privatization of the National Weather Service. This, we believe, is a detriment to public safety. In the President's Fiscal Year 1990 Budget, (see page 3-105, G. Privatization), the Administration identifies the "Weather Service" as one of the 1990 privatization initiatives, indicating that "the government will issue a policy statement clarifying those weather forecasting functions to be performed by NWS and those to be performed by the private sector." Our organization has taken a firm stance against privatization, and the Congress should prevent this from happening.

The government reduced the number of FAA aircraft inspectors, and this led to an increased incidence of accidents caused by deficient aircraft. The government reduced the number of meat inspectors in the Department of Agriculture, and this has led to a steadily increasing rate of food poisoning. The government reduced the number of air traffic controllers, and this has led to an increased number of near-collisions. The government reduced the number of OSHA inspectors, and this has led to an increased number of on-the-job accidents. The government reduced the number of weather employees, and this has led to a deterioration in the nation's forecast and warning services. Instead of privatizing the weather service, the Congress and the American people should demand a strengthened National Weather Service.

VI. IS THE INTENT OF CONGRESS BEING VIOLATED?

Public Law 100-685 contained several key provisions that we believe are being violated by NOAA. Section 108 (a) of Public Law 100-685 regarding NOAA Authorizations, states:

> "Sec. 208 (a) The Secretary shall not close, consolidate, automate, or relocate any Weather Service Office or Weather Service Forecast Office except in accordance with this section.
>
> (b) The Secretary may not close, consolidate, automate, or relocate any such office unless the Secretary has certified to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Science, Space and Technology of the House of Representatives that such action will not result in any degradation of weather services provided to the affected area. Such certification shall include -
>
> (1) a detailed comparison of the services provided to the affected area and the services to be provided after such action;
>
> (2) any recent or expected modernization of National Weather Service operations which will enhance services in the affected area; and
>
> (3) evidence, based upon operational demonstration of modernized National Weather Service operations, which supports the conclusion that no degradation in services will result from such action."

We believe that the NOAA reductions in staff and partial closings or reductions in the hours of operation for National Weather Services offices are the same as "closings" included in Public Law 100-685. Congress should investigate this circumvention of the intent of Congress by NOAA management.

In addition, Public Law 100-685 required submission of the National Weather Service modernization plan to the Congress by February 18, 1989. It was not submitted until mid-March, 1989. If we have to adhere to the laws passed by Congress, why not NOAA?

In conclusion, our organization applauds the continued support provided by this Subcommittee to maintain adequate funding for the various services and positions needed to fulfill the National Weather Service public safety role. Your courage and foresight, in this time of budget constraint, is appreciated by the federal employees of the National Weather Service.

We hope that the Congress reviews the National Weather Service policies, programs and structure. If the Congress took the occasion of the National Weather Service modernization plan to hold a series of hearings on the National Weather Service, including its role in NOAA or as a separate agency, then perhaps the Congress and the American public would receive the true picture of what is really at stake. Our organization pledges to do all it can to assist you and your colleagues in such an endeavor.

FACT SHEET ON THE STRATEGIC PLAN FOR MODERNIZATION OF THE NATIONAL WEATHER SERVICE

compiled by the
National Weather Service Employees Organization

revised March 15, 1989

The keystone of the Strategic Plan for the Modernization and Associated Restructuring of the National Weather Service is the procurement of Next Generation Radar (NEXRAD) and an Automated Surface Observation System (ASOS). NEXRAD will be installed at 115 "Warning and Forecast Offices," which will replace the 52 forecast offices and 197 smaller offices currently operated by the NWS. ASOS will be installed at 250 locations and will ostensibly automate the work currently performed by the NWS's 1,500 meteorological technicians.

Although the Department of Commerce has asked Congress for substantial sums to begin the modernization and restructuring of the NWS, the new technology on which the NWS seeks to rely is unproven. Consequently, it is the position of the National Weather Service Employees Organization that neither permanent changes to the NWS's personnel structure nor commitment of funding at the expense of current services should be made unless and until NEXRAD and ASOS have been successfully tested.

NEXRAD

- NEXRAD has yet to be tested outside of the contractor's facilities. The first test using NEXRAD in a real-life forecasting situation is scheduled to begin in Norman, Oklahoma, in April 1989.

- The NWS has promised more than doppler radar, such as NEXRAD, can deliver. Although it is possible for doppler radar to detect tornados and mesocyclones through its ability to display radial velocity data, the effective range of this enhanced detection ability is quite limited because of its beam width. For example, at a distance of 60 km (36 miles), NEXRAD will only be able to resolve weather phenomenon that is at least .25 km x .25 km. Next Generation Weather Radar Product Description Document, pp. 4-19 (December 1986). Fewer than 10% of the tornados in the eastern third of the United States are large-scale F5 tornados, and most will escape detection on NEXRAD unless they occur within 30 miles or so of the Warning and Forecast Office. The NWS plans to space the WFOs hundreds of miles apart. In fact, no WFO is planned at all for the interior of

the states of Ohio or Kentucky. The population centers of Columbus, OH; Richmond, VA; Chattanooga, TN; Charlotte and Winston-Salem, NC; Greenville, SC; Columbus and Savannah, GA; and Montgomery, AL, are each at least 100 miles from a planned NEXRAD installation.

- Other technical shortcomings of doppler radar are reported in an NWS publication, NOAA Training Paper NWS TC-1, "Doppler Weather Radar Principles", p. 19 (January 1983), including range and velocity folding (which causes erroneous replication or radar echoes), substantial delays in updates in data displays compared with conventional radar, problems in operator/user interpretation of the radar displays, and displays contaminated by insignificant or non-weather information. This publication also noted that "the small size of some types of tornadic vortices may preclude detection."

- NEXRAD was plagued by a high mechanical failure rate during testing conducted by the Air Force in 1986 and 1987 at Unisys's facilities in Bloomfield, CT, and Trevose, PA. During the 1986 tests, NEXRAD failed 138 times due to unknown causes. During the 1987 tests, NEXRAD's transmitter failed 5 times in 40 days, as opposed to the manufacturer's predicted failure rate of once in 170 days. The results of these tests, obtained by NWSEO through the Freedom of Information Act, also confirm NEXRAD's susceptibility to ground clutter contamination and velocity and range folding.

ASOS

ASOS has been more thoroughly tested than NEXRAD, but the results of the tests have been discouraging and demonstrate that fully automated weather observations are not now technologically feasible.

- Each ASOS installation will be comprised of several different sensing devices. The Precipitation Sensors Test Report, pp. ii, 4-9 (February 1988), prepared for the Joint Automated Weather Observing Program Council, reported that the freezing precipitation sensors failed to meet requirements of the ASOS program during field tests.

- ASOS is incapable of detecting cloud covers above 10,000 feet. According to the Preliminary Evaluation, Automated Surface Observing System, Kansas Pilot Project, p. 21 (September 1986), "[w]ithout cloud information above 10,000 feet, the ASOS observations alone

cannot establish total sky cover. Satellite imagery may ultimately provide only part of the solution."

- The cloud height indicator "occasionally does not detect stationary or widely scattered cumulus clouds." Preliminary Evaluations, p. 10. See also, ASOS Project Report, vol. IV, no. 3, pp. 7-8 (September 1988). It also takes thirty minutes for the cloud height indicator to detect cloud cover, while a human observer can do so instantly. Id.

- The cloud height indicator reports false readings during mild precipitation and fails completely during heavy precipitation. ASOS Project Report, vol. IV, no. 4, p. 5 (December 1, 1988).

- Testing conducted at the ASOS Kansas Pilot Project also revealed additional, unacceptable failures in automated weather observations:

> "Present weather detection was very limited in KaPP. The LWI [laser weather indicator] did not work properly and consequently did not adequately discriminate among rain, snow, drizzle and hail at Goodland and Concordia (the only two stations that have present weather sensors). Also, the detection of sleet and mixed precipitation was beyond the capability of the LWI. Elements such as lightning and freezing rain were detected with partial success. . . . The KaPP did not demonstrate adequate present weather detection capability. . . ."

Preliminary Evaluation, p. 21.

- "In a system such as ASOS, it is crucial that all components (including the basic electronics and sensors) perform in a highly consistent and reliable manner. . . . [D]egraded performance of one component impacts overall system performance." Preliminary Evaluation, p. 9.

OTHER IMPACTS

Even if the observation functions performed by the meteorological technicians could be automated, commercial and general aviation will lose the important "local aviation advisories" issued by met techs at many of the 192 Weather Service Offices to warn of impending strong winds, wind shear, and severe and winter weather.

In addition, as a result of the restructuring of the NWS, 123 small and middle-size cities will lose the NWS office located in their communities along with the public service functions it provides.

Weather Service Revamp to Improve Forecasts

Knight-Ridder

The National Weather Service yesterday unveiled a $1 billion modernization plan that it said will dramatically improve the accuracy of weather forecasts and storm warnings when it is completed in the mid-1990s, but the cost will be the loss of 800 jobs when more than half of the service's 300 local weather offices are closed.

Despite the loss of jobs, NWS Director Elbert W. Friday said, the system will provide forecasters with better data than is now available.

Friday said the service is accurate 60 percent of the time in forecasting severe thunderstorms and tornadoes. He said he expects to raise accuracy to 80 percent and to cut false tornado forecasts, now at 60 percent, to 20 percent.

Instead of less than five minutes' warning of storms, Friday said the service hopes to achieve 20 minutes or more.

Other improvements include longer-range forecasts to help farmers, better rainfall management as demand for water grows, and, in general, "fewer surprises," Friday said.

The new system has four main parts, some of which will be shared by the Defense and Transportation departments for use in military and civilian aviation:

- A nationwide network of 160 radar stations to observe the development and movement of storms.
- About 1,000 automated surface observation stations that, without human assistance, will continuously collect data on clouds, winds, temperature and moisture. The information will be relayed automatically to the weather service and the Federal Aviation Administration.
- A new enviromental satellite system, in stationary orbit 22,000 miles above the Earth, that will feed data to the weather stations below.
- A set of high-speed supercomputers at the National Meteorological Center in Camp Springs, Md., that will tie all these sources of information together. The computers will provide short-term weather forecasts twice a day and 10-day forecasts once a day.

When the system is installed, the weather service will reduce its local weather offices to 114, eliminating about 800 jobs.

Last year, Congress forbade the closing of any local weather station unless the secretary of commerce certifies that there will be no degradation in service.

WASHINGTON POST THURSDAY MARCH 16, 1989

Weather agency updating

THE ASSOCIATED PRESS

The National Weather Service announced a major modernization program yesterday that officials said will streamline the agency by eliminating more than 150 local offices and reducing the staff by 800 while producing improved forecasts.

The weather service will be reduced from nearly 300 local offices to just 115 when the changeover is completed about 1995, said Albert W. Friday, the weather service director.

He said the modernization program will reduce the agency's staff from 4,700 people to about 3,900.

No local stations will be closed, however, until the weather service is assured that its ability to provide forecasts and warnings in the affected area will not be reduced, Mr. Friday said.

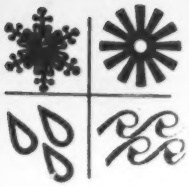
The weather service is depending on new technology to help it provide improved forecasts with fewer offices and people, he said.

Major components of the new system will be:

- The Next Generation Weather Radar that will provide much more detailed analysis of storms than current radars, which were installed in the 1960s.
- The Automated Surface Observing System, which will replace many of the current weather service offices with computerized stations that continually measure temperature, humidity, rainfall, cloud height, winds, visibility and other factors. These stations will send data now collected by people to central offices for use in writing forecasts.
- A supercomputer will be installed at the National Meteorological Center in Camp Springs, and will provide detailed weather forecasts twice a day to local weather service offices, which will use the data to develop their local forecasts.

Mr. Friday said the automated data collection and processing system will first be installed in Kansas, Oklahoma, Nebraska and Colorado and will be expanded to the remainder of the country once it is proven effective.

WASHINGTON TIMES THURSDAY MARCH 16, 1989



National Weather Service
Employees Organization
AFFILIATED WITH MEBA AFL-CIO

RESPONSE TO THE STRATEGIC PLAN FOR THE MODERNIZATION AND ASSOCIATED RESTRUCTURING OF THE NATIONAL WEATHER SERVICE AND RECOMMENDATIONS

The Response to the Strategic Plan for the Modernization and Associated Restructuring of the National Weather Service and Recommendations is published by the National Weather Service Employees Organization and written by NWSEO President John D. Quadros with the invaluable assistance of the members of the National Council, members of NWSEO, Chwat/Weigend Associates, and General Counsel Richard J. Hirn. *The Response* was edited and designed by NWSEO Director of Membership Services Peter J. Nuhn and published in Washington, DC, May 1989. Please send comments to NWSEO, 400 N. Capitol St., Suite 326, Washington, DC 20001.

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I. INTRODUCTION

In March 1989, the National Weather Service (NWS) submitted to Congress a "Strategic Plan for the Modernization and Associated Restructuring of the National Weather Service." The National Weather Service Employees Organization (NWSEO), as the representative of the affected employees, has prepared this response to that plan.

There is nothing basically wrong with the goal set by the NWS:

> "To modernize the NWS through the deployment of proven observational, information processing, and communications technologies, and to establish an associated cost-effective operational structure. The modernization and associated restructuring of NWS shall assure that the major advances which have been made in our ability to observe and understand the atmosphere are applied to the practical problems of providing weather and hydrologic services to the Nation."

What is basically wrong, and what NWSEO takes exception to, are many of the assumptions relied upon by the NWS in developing the Strategic Plan. The catchwords "cost effective" are a fact of life in the federal government as this nation heads into the 90s. The NWS Strategic Plan is <u>not</u> cost effective.

The Response to the agency's Strategic Plan contains specific recommendations that Congress and the administration will find are more cost effective, technologically sound alternatives to various aspects of the modernization and restructuring plans developed by the NWS. These forces that shape the NWS budget must be channeled to provide the American public with an adequate, modern weather service.

II. PRINCIPLES FOR THE MODERNIZATION AND ASSOCIATED RESTRUCTURING

The Strategic Plan describes the NWS mission as providing

> "weather and flood warnings, public forecasts, and advisories for all of the United States, its territories, adjacent waters and ocean areas, primarily for the protection of life and property. NWS data and products are provided to private meteorologists for the provision of all specialized services."

This statement is a major departure from the mission of the agency as stated in the NWS Organic Act of 1890:

> "The Secretary of Commerce shall have charge of the forecasting of weather, the issue of storm warnings, the display of weather and flood signals for the benefit of agriculture, commerce and navigation, the maintenance and operation of seacoast telegraph lines and the collection and transmission of marine intelligence for the benefit of commerce and navigation, the reporting of temperature and rainfall conditions for the cotton interests, the display of frost and cold-wave signals, the distribution of meteorological information in the interests of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or as are essential for the proper execution of the foregoing duties." (emphasis added)

By redefining its mission, the NWS is divorcing itself from service to the economic and business concerns of the United States. It continues the long march toward a simplified weather service, one that provides only basic public forecasts and warnings. It continues the long march toward a weather service that is uninvolved with commerce and raises the obvious question, "Why is the NWS in the Department of Commerce if it no longer intends to aid and promote the nation's commerce?". It continues the long march toward "privatization" of the NWS by stripping forecast services involving aviation, marine, satellite interpretation, fire weather, air pollution, agriculture, and fruit-frost functions from the mission and leaving them for private meteorologists. Only those who can afford such services will prosper. The economic loss is incalculable.

The Strategic Plan identifies what it terms as "essential principles." The first among these is that "the modernization and associated restructuring process will not result in degradation of services to the general public." Unfortunately, the degradation of services has already begun. To pay for the development of the new technology to date and to keep within restrictive budgets, massive decreases in programs and depletion of the work force has taken place over the past 8 years. For example, the NWS Western Region decreased from 900 positions in 1981 to 703 in 1985 and dropped to 581 by 1989 (with 69 of these currently vacant).

The second principle is that "NWS employees will be involved" in the development and implementation of the Strategic Plan "because their participation is crucial to a successful transition and improved operations." This has simply not been the case. The text goes on to discuss training,

which may be what the NWS feels is sufficient employee involvement; but training is not cheap, and the new technology is not easy to operate. If the manner in which the agency trained its employees to use AFOS--the NWS' current product composition, dissemination, and communications system--is any indication of the agency's commitment to training, we are neither optimistic nor encouraged. Did the NWS learn from the mistakes it made during AFOS training?

The Strategic Plan's third principle, "that U.S. international meteorological and hydrologic obligations will be met during and after the modernization and associated restructuring," cannot be met because the quality of observational data will deteriorate as observations are automated or turned over to less qualified non-NWS observers.

The fourth principle, "that NWS employees will continue to provide the quality weather services required by the country in the most economical manner," must take into account the fact that the NWS operational budgets can not be reduced indefinitely without a corresponding human loss or economic loss to the nation's commerce and business interests.

The Local Warning and Forecast program of the National Weather Service has an annual budget of about $240 million, or just $1 for each U.S. citizen. Does any other service to the American public come so cheaply? In comparison, the U.S. Government proposes to spend $190 million in climatological research.

RECOMMENDATIONS:

A. The Congress and the Executive Branch must take the necessary steps and provide the necessary funding to restore the NWS to its former preeminent position among world weather services.

B. The NWS must keep its Mission as stated in the Organic Act, unless changed by Congress.

C. No further work force reductions, station closures (full or part time), station relocation or consolidation, or automation of function should take place without congressional consent.

D. NWSEO, in its capacity as work force representative, should be brought in as a full participating partner in the changes that the NWS goes through in its modernization.

III. NEED TO IMPLEMENT NEW SCIENCE AND TECHNOLOGY

The Strategic Plan correctly observes that the "vintage technologies that compose part of today's weather service infrastructure need to be replaced." Many of these technologies were so long in development and production that when deployment took place, obsolescence was inherent in the system. The NWS' current computer and communications system, AFOS, is a prime example. Computer technology has been and will continue to be fast paced. The replacement system for AFOS, called the Advanced Weather Interactive Processing System (AWIPS), must be developed with the evolving nature of computer technology in mind. The system must be designed so that advances in one part of the system can be incorporated without replacing or modifying the entire system.

Advances in mesoscale meteorology, a scale that indeed is "well below the operational resolution of routine observations and analysis today," dictate concentration of forecasts and warnings at this level. To take full advantage of these advances, the technology must improve to detect meteorological parameters at this scale. To date, this is not the case. The technology has not been proven. Automated Surface Observing System (ASOS), as it is currently being developed, is not a replacement for a human observer and at best will only provide a partial supplemental surface observation. Profiler technology is still under development. Next Generation Weather Radar (NEXRAD) technology seems to improve the ability to detect severe weather and its precursors, but at a smaller radius than advertised.

When the new technology does reach the proven state, the employees using it must be adequately trained to realize its potential. Again, this was not the case when AFOS was installed.

RECOMMENDATIONS:

A. Research and development of the new technologies should continue, but implementation should only be undertaken when the new technology is proven.

B. System design, particularly of AWIPS, should be modular so that advances in part of the system will not render the entire system obsolete.

C. Once proven, the technology should be produced and deployed as rapidly as possible to take advantage of the improved capability as soon as practicable.

D. Personnel training should be properly funded so that the full benefits of the advances in the science and technology can be realized.

IV. MAJOR TECHNOLOGIES FOR MODERNIZATION

The cornerstone of any forecast system is observations. Inadequate areal coverage, unreliable equipment, or missing data all lead to a deteriorated forecast product. New equipment must be at least as reliable as present equipment.

The first major technology discussed in the Strategic Plan is ASOS. ASOS has been more thoroughly tested than NEXRAD, but the results of the tests have been discouraging and demonstrate that fully automated weather observations are not now technologically feasible.

Each ASOS installation will comprise several different sensing devices. The Precipitation Sensors Test Report, pp. ii, 4-9 (February 1988), prepared for the Joint Automated Weather Observing Program Council, reported that the freezing precipitation sensors failed to meet requirements of the ASOS program during field tests.

ASOS is incapable of detecting cloud cover above 10,000 feet. According to the Preliminary Evaluation, Automated Surface Observing System, Kansas Pilot Project, p. 21 (September 1986), "(w)ithout cloud information above 10,000 feet, the ASOS observations alone cannot establish total sky cover. Satellite imagery may ultimately provide only part of the solution."

The cloud height indicator "occasionally does not detect stationary or widely scattered cumulus clouds," Preliminary Evaluation, p. 10. See also, ASOS Project Report, Vol. IV, No. 3, pp. 7-8 (September 1988). Furthermore, it takes 30 minutes for the cloud height indicator to detect cloud cover, while a human observer can do so instantly. Id.

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Testing conducted at the ASOS Kansas Pilot Project (KaPP) also revealed additional, unacceptable failures in automated weather observations:

> "Present weather detection was very limited in KaPP. The LWI (laser weather indicator) did not work properly and consequently did not adequately discriminate among rain, snow, drizzle and hail at Goodland and Concordia (the only two stations that have present weather sensors). Also, the detection of sleet and mixed precipitation was beyond the capability of the LWI. Elements such as lightning and freezing rain were detected with partial success....The KaPP did not demonstrate adequate present weather detection capability...." Preliminary Evaluation, p. 21.

> "In a system such as ASOS, it is crucial that all components (including the basic electronics and sensors) perform in a highly consistent and reliable manner...(D)egraded performance of one component impacts overall system performance." Preliminary Evaluation, p. 9.

The second major technology discussed in the Strategic Plan is NEXRAD. NWSEO's main concerns about this system are that it be evaluated properly and certified by independent observers as a proven system before full-scale procurement and that Congress and the American public not be oversold on the technology.

Until late March 1989, NEXRAD had not been tested outside the contractor's facilities. This first test using NEXRAD in a real life forecasting situation is being run in Norman, OK. The testing is being conducted under a veil of secrecy. All personnel working at or visiting the test site are required by the U.S. Air Force to sign a statement of non-disclosure. This may be intended to prevent leaks of unrepresentative results, but it leads to the appearance of a cover-up of the testing process.

The NWS has promised more than Doppler radar, such as NEXRAD, can deliver. Although it is possible for Doppler radar to detect tornadoes and mesocyclones through its ability to display radial velocity data, the effective range of this enhanced detection ability is quite limited because of its beam width. For example, at a distance of 60 km (36 miles), NEXRAD will only be able to resolve weather phenomenon that is at least .25 km by .25 km. Next Generation Weather Radar Product Description Document (December 1986). Fewer than 10% of the tornadoes in the eastern third of the United States are large-scale F5 tornadoes, and most will escape detection on NEXRAD unless they occur within 30 miles or so

of the Weather Forecast Office (WFO). The NWS plans to space the Weather Forecast Offices hundreds of miles apart. In fact, no WFO is planned at all for the interior of the states of Ohio and Kentucky. The population centers of Columbus, OH; Richmond, VA; Chattanooga, TN; Charlotte and Winston-Salem, NC; Greenville, SC; Columbus and Savannah, GA; and Montgomery, AL, are each at least 100 miles from a planned NEXRAD location. Recent devastating tornadoes in Wichita Falls, Waco, Paris, and Saragossa, TX, would not have been caught by the planned NEXRAD network.

Other technical shortcomings of Doppler radar are reported in the NWS publication NOAA Training Paper NWS TC-1, "Doppler Weather Radar Principles," p. 19 (January 1983), including range and velocity folding (which causes erroneous replication of radar echoes), substantial delays in updates in data displays compared with conventional radar, problems in operator/user interpretation of the radar displays, and displays contaminated by insignificant or nonweather information. This publication also noted that "the small size of some types of tornadic vortices may preclude detection."

NEXRAD was plagued by a high mechanical failure rate during testing by the Air Force in 1986 and 1987 at UNISYS's facilities in Bloomfield, CT, and Trevose, PA. During the 1986 tests, NEXRAD failed 138 times due to unknown causes. During the 1987 tests, NEXRAD's transmitter failed 5 times in 40 days, as opposed to the manufacturer's predicted failure rate of once in 170 days. The results of these tests, obtained by NWSEO through the Freedom of Information Act, also confirm NEXRAD's susceptibility to ground clutter contamination and velocity and range folding.

The Strategic Plan next discusses satellite upgrades. The field eagerly anticipates the new generation of Geostationary Operational Environmental Satellite (GOES) (I through M) and the new generation of NOAA satellites (K through M). The two geostationary, two polar orbiter satellite configuration is a necessity, not a luxury. Attacks on this configuration, usually brought about by budget considerations, are ludicrous. Through a combination of bad luck and bad planning this country now has only one operational geostationary satellite. There is no guarantee that this satellite will last until the next geostationary satellite launch, slated for mid-1990. Even if the current GOES survives and the new GOES satellite is successfully launched, the chances are high of reverting to a one satellite mode before GOES J is launched in 1992.

We agree with the NWS that "the future requirement for guidance products for mesoscale warnings and forecasts is greatly increased over the present" and that this supports the acquisition of a Class VII computer.

Recent moves by OMB changed the request for Class VII computers to computers with Class VII capabilities. This is a subtle but significant difference. We favor the acquisition of the most up-to-date technology and not mere modification of the NWS' existing computers. One of the reasons this country's weather service has fallen behind the rest of the world is its inability to keep current in state-of-the-art computer systems. Europeans have demonstrated an ability with new generation computers to outforecast the United States in both smaller scale and longer range.

AWIPS will replace AFOS as the system that integrates data, analysis and guidance products to aid in the formulation of warnings and forecasts. Dr. Joanne Simpson, president of the American Meteorological Society, stated in testimony before Congress, "There are five tightly meshed components which must be moved forward in a synchronized orderly fashion so that the whole system is completely in place as soon as possible." And, she says, "(i)t is essential that the AWIPS be kept in phase with the other components of the upgrade" (her emphasis).

The AWIPS section of the Plan includes discussion of NOAAPORT. NOAAPORT takes the current dissemination system one step closer to outright sale of weather data and products. A contract vendor would charge for the receipt of products and control their dissemination by use of such methods as encrypting devices. Access would be limited to those with the means to pay for desired services. The NWS has already signed a contract with Weather Services Incorporated (WSI). WSI is marketing radar composites to their clients. With such contract vendors as the ones set up through NOAAPORT and WSI, small users would be at a disadvantage, and newcomers into the field of private meteorology would have a bigger obstacle to overcome.

RECOMMENDATIONS:

A. In light of the many problems with ASOS, the Strategic Plan should have detailed plans for its use. What human supplementation is necessary? Who will do it? Who will pay for it? These questions need to be answered before the system is implemented.

B. In light of the many problems with NEXRAD, further testing in real life forecasting situations must be completed and independently assessed before procurement of the system proceeds. The veil of secrecy surrounding the testing should be lifted.

C. The NEXRAD system should not be oversold. Realistic expectations of the Doppler technology should be documented. The public should be frankly informed that the effective range of the Doppler feature of NEXRAD is limited and that many small and medium sized cities will not benefit from the acquisition by the NWS of Doppler technology because of their distance from planned radar sites.

D. The two geostationary, two polar orbiter configuration of U.S. satellites should be restored with adequate back-ups available to reasonably account for rocket or equipment failure.

E. Acquisition of a Class VII computer is a necessity. The United States should commit itself to staying on the edge of the technology, rather than trailing behind the rest of the world's technological leaders.

F. The AWIPS technology must evolve in synchronization with the other new technologies and allow for periodic upgrades (not long-term replacement) as the technology advances. The NWS must not repeat the mistakes of AFOS implementation.

G. The concept of NOAAPORT should be rethought. It is not right to contract out control of weather data and products. Costs should be limited to legitimate dissemination expense.

H. Training of personnel in the new technologies must be a top priority and adequately funded. Only proper training will allow expensive new technology to serve the American public to its maximum capability.

V. NEED TO RESTRUCTURE

A restructured weather service to take full advantage of the new science and technology is basically a good idea, but should be undertaken for that reason alone. The current structure has undergone periodic changes, driven purely by budget considerations. The current structure has become inefficient and an outright danger to the American public due to service cutbacks, understaffed offices, aging technology and a demoralized work force.

The Plan states that "the percentage increase in meteorologists in the NWS work force will improve warnings and forecasts by taking advantage of the capabilities of the new technologies." It is NWSEO's contention that meteorological technicians, particularly those working with existing radar, and those with meteorology and related degrees are also fully capable of taking advantage of the new technologies. The U.S. Air Force, which will also utilize NEXRAD, has determined that their system will be manned by NCOs. Many NWS met techs are former NCOs with radar and forecast experience. The Air Force values its NCOs. Why doesn't the NWS value its met techs? The work force should reflect a more even mix of mets and met techs.

The plan goes on to say that "an increased effective range of the radar systems and the ability to assemble all data at a reduced number of offices increases productivity and efficiency." Nowhere has there been any demonstrated increase in the effective range of the conventional radar, and as discussed, the effective range of the Doppler function is quite limited and far less than the effective range of conventional radar technology. Nowhere has it been proven that a reduction in the number of offices will lead to increased productivity. By this same convoluted argument, one could assume that a reduction of offices to zero would be the most productive form of restructuring.

RECOMMENDATIONS:

A. Restructuring should be driven by the implementation of the new technologies.

B. The work force balance between mets and met techs should be more even, so as not to discard the radar interpretation talents of a significant portion of the current met tech work force.

VI. WFO AREA OF RESPONSIBILITY AND INTEGRATED OPERATIONS WITHIN THE WFO

The Strategic Plan provides a map depicting the NEXRAD coverage over the continental United States. This map shows circles drawn at a radius of 125 miles around each of the radar sites. East of the Mississippi River there are no gaps depicted in the coverage. To the west, however, there are gaps in the Rocky Mountains and to the east of the Cascades and Sierra Nevada. The map equates to maximum radar coverage at the

NEXRAD SITES WITH OPTIMUM COVERAGE FOR DETECTION OF TORNADO VORTEX SIGNATURES (70 km)

Figure 1

10,000 foot level. This level is of course above much of the weather that affects the United States and limits the coverage of the conventional radar mode to about this 125 mile distance. Also affecting the coverage would be the height of the radar itself. For instance, the radar serving the 5 million people in the San Francisco-Oakland-San Jose metropolitan area will be situated at 3,000 feet, above much of the weather that affects that area.

Figure 1 depicts optimum coverage for detection of tornado vortex signatures. Beyond this distance, tornadoes can only be deduced from detection of mesocyclones, weather systems which can spawn tornadoes. However, limitations imposed by the beam width also affect detection of mesocyclones.

The NWS has operated prototype offices utilizing some of the new technology for the past few years. At the Oklahoma City Weather Service Forecast Office (WSFO), forecasters have a drop on the Doppler radar operated at the National Severe Storms Laboratory (NSSL) in Norman. According to the Strategic Plan Verification/Evaluation Update, March 1989, severe thunderstorm verification was better than the rest of the forecast offices in the Southern Region by a 2:1 margin. Two facts temper those results. First, the NSSL radar has a .50 degree beam width as compared to NEXRAD's .95 degree. The narrower NSSL beam width will produce better resolution. Second, the Update concludes that "tornado results by themselves were not impressive."

Statistics show that 2/3 of the warnings issued by the WSFO in Oklahoma City were for areas less than 50 miles from the office and only one warning in 7 was for an area greater than 100 miles from the office, Strategic Plan Verification/Evaluation Update. This shows the limited range of the Doppler feature, and is a strong argument for more closely spaced NEXRAD sites.

In Denver, The Program for Regional Observing and Forecasting Services (PROFS) has made both new and conventional data sets available in real-time to the forecasters at the Forecast Office. The new data sets are produced from a workstation that is a forerunner of AWIPS. In addition, a Doppler radar is available. Early results, although very limited in scope, are encouraging with an increase in warning lead time, and a decrease in the average area warned during each severe weather episode, Strategic Plan Verification/Evaluation Update.

If the radar coverage is inadequate from the standpoint of normal radar detection capabilities, and certainly inadequate for Doppler capabilities, what drove the determination that approximately 115 sites would be needed? A letter from the head of the NWS to the head of NOAA states

that there are "solid technical justifications for 15-20 additional Weather Forecast Offices." Was it a case of first determining what amount of money the Office of Management and Budget (OMB) would allocate for NEXRAD (the most expensive component of modernization) and then determining the number of NEXRADs? In other words, it is obvious that budgetary considerations were the deciding factor in the size of the NEXRAD network. Were these same budgetary considerations the reason it will take so long to implement the system, even after it is tested and independently certified?

Every NEXRAD will have an associated WFO. The mentality behind the design of the WFO can best be described as the "cookie cutter syndrome." Every WFO will be nearly identical. Each will have its own NEXRAD. Each will have very similar staffing. Each will have the same forecast programs. There are strong arguments against this approach: (1) precipitation patterns vary from one part of the country to the next; (2) temperature patterns also vary; (3) the user community is uniquely different at each location; (4) population of each WFO's area can vary from a few thousand to 10 million; (5) topography is widely variable across the country; and (6) the size of the area served by each WFO can vary considerably.

To accommodate this cookie cutter approach to future NWS operations, specialized programs are being systematically stripped from the field and placed into remote national centers, which have become clearing houses for any forecast program that won't fit. Forecasts for agricultural interests including the fruit frost program are being abandoned. Even farmers who can afford to hire private meteorologists don't want this program to end. Those who can't afford the service will suffer the consequences. Aviation area forecasts, high seas and offshore forecasts, and satellite interpretation are being consolidated in national centers far removed from the area of responsibility. The "bull's-eye effect" is real. This means better services in close proximity of the offices, but a significant degradation of services in those communities that are not near a WFO. A study prepared by the NWS Services Evaluation Branch shows that both temperature and precipitation forecasts are better when prepared locally as opposed to remotely by a national center, Strategic Plan Verification/Evaluation Update. Other nations have learned the folly of this thinking. The United States must not repeat this mistake. No one wants to be responsible for the consequences.

RECOMMENDATIONS:

A. If proven, determine how many NEXRADs are really needed. Consider deployment of new conventional radars in the mountainous West where the Doppler capability is least needed and will provide the least benefit.

B. Rethink the cookie cutter approach. Accept the fact that there are many variables in the system. Tailor staffing and programs to the needs of the user community and physical characteristics of each WFO area.

C. Have the NWS disclose which 15-20 additional NEXRAD/WFO sites are justified and add them to the Plan.

D. Reestablish a Pacific coast national center for the Pacific Ocean high seas and offshore marine forecasts and GOES West satellite interpretation.

VII. THE NEW STRUCTURE

The most striking feature of the new structure proposed for the NWS under modernization is how dramatically the field changes in relation to the national centers. Despite the dramatic reduction in number of offices (from a high of about 300 a few years back to about 250 currently and 115 in the mid 90s), there is little or no change planned for the national centers, except for technology.

The Plan mentions that operations at the 13 River Forecast Centers (RFCs) will be expanded to 16 hours per day to take advantage of expanded data input. Again, budget considerations come to the fore. Why, if data is now going to be routinely available around the clock, are the centers only going to operate 16 hours per day? Weather knows no clock. The likelihood of hydrologic events is just as great on the midnight shift as at any other time. Support to the field is needed on a continual basis.

No change in staffing or mission is slated for the National Meteorological Center, The Climate Analysis Center, the National Hurricane Center, the National Severe Storms Forecast Center or the National Data Buoy Center. If upwards of 150-180 cities are losing their local weather office, who will continue the valuable work of setting up and maintaining spotter networks, local climate networks, and community preparedness. Or will

these programs fall victim to the mistaken assumption that new technology will render them obsolete?

No mention is made in the Plan of regional headquarters under the modernized NWS. Will as many still be needed? No mention is made of regional or area forecast coordination centers. Currently, there are 52 autonomous Forecast Offices. In the new system this number will more than double. The chances of conflicting forecasts will be greatly increased, much to the detriment of the products provided to the public.

An earlier version of the Plan included 50-80 Community Service Offices (CSOs) and Local Weather Offices (LWOs). OMB stripped those offices from that earlier Plan. Those offices, staffed on a part-time basis, would have continued many of the valuable weather support functions to local communities that will be lost under the current Plan.

RECOMMENDATIONS:

A. Study the national centers for changes necessitated by such a large change in the field structure.

B. Operate the RFCs on a full time basis. Either their support is vital all of the time or not at all.

C. Assure that there is continuity of community interaction programs. This burden must be shared at the national centers and not foisted entirely upon a reduced field structure.

D. Reduce the number of regional offices. Fewer employees in the field need less support at this level.

E. Reintroduce the concept of regional or area forecast coordination centers.

F. Restore to the plan the 50-80 CSOs and LWOs originally intended.

VIII. STAFFING

The Strategic Plan is devoid of details as to number and grades of staff at the WFO. The text lists "a core staff of professional scientists," "meteo-

rological technicians," "electronic technicians," a "Meteorologist-In-Charge," and a nebulous "support staff" that will provide "critical program and maintenance support to ensure efficient operations and for the practice of advanced applied science." Additionally, some WFOs will have Service Hydrologists.

NWSEO has been informed that expected staffing at a WFO will allow for two meteorologists and one meteorological technician per shift, except for reduced coverage of one meteorologist on the midnight shift. This would mean 8 mets and 5 met techs per station in the operating unit for a nationwide total of 920 mets and 575 met techs.

The projected number of electronics technicians is unknown (a document prepared in conjunction with a technical advisory committee lists one el tech per WFO). It is known that preparations for NEXRAD maintenance training are under way at the National Weather Service Technical Training Center in Kansas City. It is also known that NWS el techs will provide maintenance not only for NWS ASOS units but also for those operated by the Federal Aviation Administration (FAA).

Any way you look at it, all of this represents a decrease in the number of field employees in the NWS. Personnel costs make up the bulk of any agency's budget. It is apparent that DOC/NOAA has struck a deal with the devil. OMB has extracted the soul of the NWS in exchange for granting budget monies for the new technology.

The insidious practice of "fair weather staffing" will persist in the NWS into the next century. It is just plain bad management to provide for coverage under the best of conditions, while relying on dedicated employees, overtime, and support staff to cover in the worst of times. This practice has brought morale in the NWS to its lowest level in history. The seed that has been planted in such a climate can not help but bear bad fruit.

RECOMMENDATIONS:

A. Adjust staffing to a level between minimum and maximum workload requirements. "Fair weather staffing" will cost the American public more in the long run.

B. As in Section VI, tailor staffing and programs to the needs of the user community and physical characteristics of each WFO area.

IX. TRANSITION PLANNING

To get from the NWS of today to the modernized NWS of tomorrow, the Strategic Plan discusses the need for a transition plan. This planning has proceeded virtually unnoticed by field personnel with only a mixture of rumor and leaked fact reaching the average employee. Rather than pass on information about the future, a veil of secrecy has surrounded the planning. The Transition Program Office came into being only recently when, evidently, there was a belated realization that the transition must be a coordinated event. Even today the office operates with a minimal staff.

Technology will be phased in over a long period of time. Many station relocations and closures will take place, necessitating shifting of personnel. New systems will have to work side by side with the old until all of the new technology is in place. The new WFO structure will have to straddle both the old way of doing things and the new.

A four-tier structure is put forth to accomplish the transition. The top tier is the Strategic Plan itself. The second tier is the National Implementation Plan, which presumably will flesh out the Strategic Plan. The third and fourth tiers will be Regional and Site Transition Plans, which will bring the National Implementation Plan down to the station level. There is nothing wrong with this structure providing (1) employee input through NWSEO is solicited and worked into the plans and (2) the Transition Program Office coordinates the Regional and Site Plans and has the latitude to properly manage the transition.

The last paragraph in this section of the Strategic Plan states, "(T)he breadth of future operations and services is bounded by the agency mission and scientific and technological capability." If only this were true. The main governing factor on the breadth of future operations and services will continue to be budget considerations. Nowhere else in government will there be such a direct relationship between money spent and service rendered.

RECOMMENDATIONS:

A. The Transition Program Office should solicit and assimilate suggestions from the employees of the NWS on modernization by placing an NWSEO representative on its staff.

B. A more detailed plan for the future NWS operation should be provided to NWS employees through NWSEO in advance of the required submission to Congress.

X. DEMONSTRATION, CERTIFICATION, AND IMPLEMENTATION

The NWS plans to test the new technology and the new structure in the central United States in a program called the Modernization and Associated Restructuring Demonstration (MARD). Unfortunately, reductions in the FY90 budget will delay the beginning of the demonstration.

In the meantime, testing of the NEXRAD system will continue in Oklahoma. This is a critical phase in the development of this technology. NEXRAD must operate in a reliable manner in a real time forecast environment away from the UNISYS facility. The testing must include evaluation of the Doppler feature's real operating range, evaluation of the system's detection capabilities in a conventional mode, evaluation of an operational forecaster's ability to utilize the system to its maximum potential, and evaluation of the system's ability to operate with a minimum of down time.

When properly certified, NEXRAD will be deployed not only as a part of the MARD experiment but at operational sites near Oklahoma City, OK; Melbourne, FL; and Washington, DC. The latter two sites will allow testing in a coastal and large urban area environment, respectively. This is important because each NEXRAD site will pose unique problems. Another major test area should be the mountainous West. Will the NEXRAD capabilities be fully realized in this terrain? Will siting at high elevations negate some of the advantages of the system? Can new conventional radar do the job in the West at a reduced cost?

ASOS has not demonstrated the ability to produce complete surface observations without human supplementation. Current regulations require that a complete surface observation be available to the forecaster before an aviation terminal forecast can be issued. If a critical element of the observation is missing, no terminal forecast is available, which can seriously affect commercial and private aviation operations. Whoever is chosen to supplement the ASOS observation, it must be their primary duty. Currently, with part-time closures of weather service offices, observation responsibility has fallen on air traffic controllers, flight service specialists, and airline personnel. A continuous weather watch is not their primary duty, and the resultant deterioration in the observations is apparent to all. The critical functions of controlling aircraft operations and briefing pilots

are their primary concerns. Supplementation of observations must be accomplished by NWS employees or contract observers.

Recently, a decision was made that NWS electronics technicians would maintain the entire ASOS network, which includes not only NWS sensors but also those of the FAA. At locations where observations support a terminal forecast, response time must be quick. With the proposed staffing of just one electronics technician per WFO, this may prove difficult.

AWIPS development lags in relation to the other components of the modernization. Procurement, demonstration, and certification of this system must proceed in a timely, coordinated manner. Much wasted effort will result if the new technology must be integrated first with the antiquated, overburdened AFOS system and then shifted to AWIPS. Moving AFOS hardware to a new office location only to have it scrapped in a relatively short time after the move is not cost effective.

When the proven technology is ready for implementation, the process must move more quickly than present plans indicate. Slow implementation will increase the period of time in which the NWS as a whole is disrupted by the modernization process. The speed of implementation should not be determined by budget restrictions.

RECOMMENDATIONS:

A. Budget restrictions must not delay MARD, a vital step in the certification of the modernization.

B. Upon completion of NEXRAD testing, make known the true capabilities of the system so that a proper evaluation of WFO distribution can be made.

C. Before implementing the full system nationwide, use the early sites to test the modernization concept not just in the Midwest but also at coastal sites, in large urban centers, and in mountainous terrain.

D. Supplement the ASOS system with human observers, at least at locations for which aviation terminal forecasts are prepared, with individuals whose primary duty is weather observing.

E. Augment the electronics technician staffing to take into account recently added responsibility. If equipment of other agencies is being maintained, obtain ET funding from that agency.

F. Develop AWIPS in conjunction with the other technologies.

G. Implement the proven technology as rapidly as is practicable.

XI. EXPERIMENTAL SYSTEMS

Brief mention is made in the Strategic Plan about wind and thermodynamic profilers. The objective of these systems is to provide moisture readings and data on temperature and atmospheric winds at a higher resolution and lower cost than present systems. Again, technology of this type will provide an expanded data base, which, in turn, will lead to a better forecast. Additionally, the need for a Class VII computer and new forecast models is reinforced.

RECOMMENDATION:

A. Continue development of profiler technology with efforts made to integrate this technology into the modernized weather service when proven.

XII. PRODUCTIVITY AND EFFICIENCY ADVANTAGES

The Strategic Plan draws a number of conclusions from the NWS plan to modernize and restructure the complete system. First, it asserts that "(p)roductivity and service improvements will be achieved by automating observation and communication duties." The time saved by automation of these often tedious duties will certainly lead to improved productivity and service. However, as discussed earlier, the automation of observations must not result in a degraded observation, nor must the automation of communications result in another overloaded, labor-intensive system like AFOS. It is vital that the modernization result in a better observation network with a user friendly, capable communications system. Only then can the full promise of productivity and service improvements be realized.

The second conclusion drawn is that "(u)sing more data with fewer offices and a core of professional personnel translates into higher produc-

tivity." This conclusion is certainly fuzzier than the first one. It can probably be shown that more data (assuming that they are of consistently good quality) will result in a better product.

What is not obvious, though, is that fewer offices (with fewer personnel) will be more productive. The current system features 52 forecast offices with 197 weather service offices. The Strategic Plan will reduce the total number to just 115. This will approximately double the area of responsibility that any one office will have.

Nor is it obvious that the Plan's heavy emphasis on what it terms as "professional staffing" (thus implying that met techs are non-professional) will result in more productivity. The NWS has alluded to studies that purportedly show that meteorologists verify severe weather warnings better than meteorological technicians. These studies have never been made public for criticism, verification, or interpretation, if in fact they exist. Attrition alone will not reduce the met tech staff in the NWS to the 575 operational positions in the WFOs. It would be wrong for the NWS to turn its back on the met tech work force, squandering a wealth of meteorological knowledge and experience.

RECOMMENDATIONS:

A. The number of stations needed to adequately cover the United States (and its territories) must be recalculated. The budget should fit the real need, not the reverse.

B. The discarding of met tech talent should not be allowed.

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Mr. SCHEUER. Thank you very much, Mr. Quadros.

There may be two perceptions of this whole privatization plan, one in the executive branch, and perhaps in the Office of Management and Budget, that is viable. But I assure you, on Capitol Hill it is not viable, and if they come up with such a privatization plan, there will be carnage wreaked upon such a plan up here. There is absolutely no support on Capitol Hill, on either side of the aisle, for privatization of the National Weather Service.

Can I make that as a categorical statement, Bob? Did you wish to comment? Am I over-reaching in making that statement?

Mr. WALKER. Well, I think you make a statement that is true if you talk about the overall program. I think that there are a number of us who believe that there are elements of what we do in weather activities that might be able to be privatized, and so that, you know, I'm not certain that you can categorically say that everything that the Weather Service is now doing or that NOAA is now doing is something that we can't look at toward some private activities.

The fact is that there are some private forecasting services in the country that do an excellent job, and to tie the Government into some of that activity would not be all that bad a thing, so that there are ways of doing that. I think that we ought to look at some of those, and I think that there would be some support on Capitol Hill for looking at that.

If you are talking about just striking the Weather Service and turning it over to private, no, I don't think there's much support on Capitol Hill for that.

Mr. SCHEUER. That's a credible statement, and if there is any serious effort looming up ahead on the part of the weather bureau to engage in massive privatization, you can be sure we will schedule hearings very, very promptly.

Bob, do you have any questions?

Mr. WALKER. Yes, I do have a couple of questions.

Dr. Simpson, in your view, are there any weather stations that purely on technical grounds ought to be looked at for possible closure?

Ms. SIMPSON. I think, partly as this gentleman said and as we say in our position paper, that you have to test, install, and test out the new technology. I think the new technology is potentially great. I mean on a research mode we have worked with this kind of technology, and it requires people, and it requires testing, and I think it may be possible to phase out or to reduce the staffing or to change the staffing of some stations after the technology has been proved out. But at this time, no.

Mr. WALKER. In other words, virtually every weather station that is now open in the country is absolutely essential and can be justified on purely technical grounds—forgetting the employee and level and so on—that there is no weather station anywhere in the country that is not a candidate for closure?

Ms. SIMPSON. Well, I wouldn't be prepared to swear on a Bible that there isn't one weather station somewhere whereby the public could be protected equally well if it weren't there, but I think it requires very careful examination, and I wouldn't think of recom-

mending that any one of the stations be closed without being very carefully sure about it.

It's not only the matter of issuing warnings to protect life and property, which are of top priority, but it's also a matter of keeping data records, and if you close a station that you've had 100 years of data record, how are we going to know that the climate is changing? It's extremely important to keep the observational facilities going.

Therefore, as a scientist as well as somebody concerned with the weather forecasts, I'd say it's a dangerous business and probably uneconomic.

Mr. SCHEUER. Will the gentleman yield to me?

Mr. WALKER. Well, I want to follow up with another question. I have to leave at ten after, so if I could just follow up.

Mr. SCHEUER. Okay.

Mr. WALKER. The thing that bothers me a little bit is, I was over recently in Geneva and was talking to the people at the World Meteorological Association. They told me very flatly that there is some problem with weather forecasting in the United States that primarily evolves from chauvinism in the United States.

Mr. SCHEUER. From what, Bob?

Mr. WALKER. From chauvinism with regard to weather forecasting—that the United States does not, for instance, make use of a lot of the world data that other nations make use of and that, in fact, in Europe they are able to give fairly good five-day forecasts to people in Europe largely because they rely upon a body of data that is generated out of world organizations, but the United States has, over the years, basically refused to tie into that network, and, as a result of our own desire to be our own bosses and so on, we are not giving as good a weather forecasting as many other places in the world are capable of giving.

I'd like to hear your response to that, because they said that very flatly in conversation.

Ms. SIMPSON. Mr. Chairman, may I respond to that?

Mr. SCHEUER. By all means.

Ms. SIMPSON. It is very clearly true that in weather forecasts, particularly medium-range forecasts, but also, I believe, in terms of short-range weather warnings, we are behind other countries in the world, and this is really unfortunate, and—

Mr. SCHEUER. But, excuse me. What Congressman Walker is—

Ms. SIMPSON. I'm going to say what I believe. I don't believe the reason is quite what you say, although that may be a contributing factor. I think where we have gone wrong is not bringing the research and operational communities, the top-notch people, closely together.

If you visit ECMWF in Reading, England, they have the top researchers working right closely with the forecasters, so that research products are fed right into the operational models and the operational models are familiar to the researchers, so that they know what is wrong and what needs to be done to improve them, and they also have better computers which, ironically, are built in the United States.

Mr. WALKER. But let me make my point here.

Ms. SIMPSON. But I think we use the data from all over the world.

Mr. WALKER. But what they are saying is that, because they tie into a worldwide system and are not so heavily protective of their own systems and so on but understand that there is a worldwide context of weather, that they are able to give longer-range, more accurate forecasts.

It sounds to me very much like we often in this country decide that we are going to protect the jobs of the union, protect stations that are in place, do all of these things, even if it means that we cannot upgrade technologically.

Well, you shake your head no. My understanding of the situation is that in order to protect a lot of what may be technically obsolete stations, that what we may have to do is cut into the NEXRAD budget.

Now if we end up doing that, we will be even further behind and we will still not be tied into the world weather system, and instead of getting better forecasting the American people are going to continue to get worse forecasting that you, yourself, admit is the case, that there are people in the world who are getting better weather forecasts than we are. That means farmers are, it means that businesses are, they are getting better forecasting, and we are spending millions and millions of dollars on things which don't tie us in properly to that system.

Ms. SIMPSON. Mr. Chairman, I believe that we are tied into all the weather information in the world, the satellites of other nations. If you look at the weather maps at NMC and the data that they use for their objective analysis to assimilate into their models to initialize them, it is data from all over the world—Australia, Europe, China, everywhere data exists.

Mr. WALKER. Well, Mr. Chairman, the only thing I would say is, the World Meteorological Association—Organization disagrees with that. They are the ones. I didn't even know this. They are the ones who raised the topic with me. They told me flatly that the United States, because it is protective of its own systems, is not as tied into these world forecasting systems as it should it and that we thereby lose the ability to predict weather as accurately as some of the rest of the world is, and I think that that is something that we need to be a little more conscious of, and I thank you, Mr. Chairman.

Mr. SCHEUER. Well, I think the gentleman raises a very legitimate point, and this committee ought to investigate it. We are going to be over, as you know, on committee work during June, and I think we ought to make a stop at the WMO and investigate this point you make.

Let me say, and I'll say this now as a partisan Democrat, that it might have been that in years gone by we might have fought to preserve jobs and we might have opposed any closing because it lost jobs. Those days are gone forever. We have to make do and get the biggest bang for our buck for every dollar that we spend on the National Weather Service or anywhere else.

As the Congressman pointed out—and we had long discussions of this, Bob, this morning before you came here—the business of reprogramming money from NEXRAD to the Weather Service is anathema, it is absolutely anathema, and if there is one dollar of

waste that we can squeeze out of the National Weather Service, that means we can get more rehabilitation and renovation, we can get a higher quality of service, we don't have to rob from Peter to save Paul.

I don't believe there would be any support in this subcommittee, or in this committee, or in this Congress, for opposing the closing of any National Weather Service station simply because of the single fact that jobs were lost. We are trying to close air bases, we are trying to close military installations of all kinds across the country. Jobs are lost as a cause of that, but that is what we are looking for, to reduce unnecessary Government employment of any kind that is not productive and doesn't contribute to the national welfare in some way.

Mr. WALKER. Mr. Chairman, if I could, and I appreciate your statement, and I would agree with you, I think it would be very valuable for the committee to go and get additional briefings on this information, because I think what the World Meteorological people will tell you is that they believe that there is a great wealth of information out there that we attempt to duplicate in this country and that what we could do is tie into those world systems and thereby not have duplicative kinds of efforts in this country, and that the result would be a far more accurate system, a system which would give us at least the kind of accuracy that the European countries have come to expect. I think that would be very, very valuable.

Mr. SCHEUER. And at lesser cost.

Mr. WALKER. That's right; that's exactly right.

Mr. SCHEUER. I couldn't agree with you more, and we will do that, and we will look to you for counsel and advice as to how to set that up and who we ought to be seeing. I appreciate your remarks.

Mr. WALKER. Thank you, Mr. Chairman.

Mr. SCHEUER. Mr. Quadros, do you feel there ought to be additional employment in the National Weather Service to staff these offices properly and to improve the quality of service?

Mr. QUADROS. Okay. I don't think anyone is advocating going back to the numbers that we had back in 1981, but I think we have a number authorized at this point that is still somewhat below what is actually needed, but I think these stations should be staffed back to at least that level.

For instance, the numbers that I gave in the Western Region showing that it dropped from 900 in 1981 to 581 today, with 69 of those vacant, I think we would certainly advocate getting it back closer to that 581 authorized figure.

Mr. SCHEUER. Of course, if you put in modern technology, it is quite possible that you can make do with less labor.

Mr. QUADROS. I think that goes without question.

Mr. SCHEUER. Pardon?

Mr. QUADROS. That goes without question.

Mr. SCHEUER. Well, if that goes without question, then perhaps some of these jobs that were x-ed out might be jobs that are not missed, might be personnel that aren't needed, in view of the capability of the new technology. Isn't that the reason we frequently install new technology?

Mr. QUADROS. Well, what I am afraid has happened, though, is that we are putting the cart before the horse. We have reduced the numbers before the technology is here.

Mr. SCHEUER. Well, that would result in a diminution of the quality and the level of service, and nobody would be in favor of that.

Now your testimony does express a great deal of skepticism regarding the new technologies that are being procured to modernize the National Weather Service. Is it your feeling that these technologies are not sufficiently tested before being contracted for?

Mr. QUADROS. I feel that the real problem comes with the overselling of what the NEXRAD technology in particular will do. It is my understanding from reports that I have seen about the NEXRAD that the operational range, the detection capabilities of the average tornado in this country, is not on the order of 125 miles or 200 miles, it is more on the order of 40 to 50 or 60 miles, and that only that distance around each of the NEXRAD sites will we have a good, substantial improvement—

Mr. SCHEUER. Repeat that last—pull your mike in, please, and repeat that last sentence; I didn't really get it.

Mr. QUADROS. From the reports that I've seen, the feeling is that the technology of NEXRAD is only going to be able to detect the average tornado out to a distance of 40 to 60 miles from the set and not out to the distance needed to cover all the space between that NEXRAD site and the one adjacent to it.

Mr. SCHEUER. So there would be gaps, is what you are saying.

Mr. QUADROS. That's what I'm saying.

Mr. SCHEUER. There will be vacuum areas.

Mr. QUADROS. Yes.

Mr. SCHEUER. Well, I think that is something that we ought to know, and maybe you can supply those studies and reports to us.

Did you want to talk on that?

Ms. SIMPSON. Yes, I would like to say something on that point.

What he says about the direct detection is absolutely correct. However, if the research and operational component of the technology upgrade is put together, we are going to be able to make predictions that will say in such and such an area there are symptoms of incipient severe events to watch out for, which we have never been able to do before.

Mr. SCHEUER. And you could avoid the gaps or the vacuum areas that are not being sufficiently covered?

Ms. SIMPSON. Well, the vacuum areas are bigger vacuums right now with the old, obsolete equipment.

Mr. SCHEUER. Right. Well, we are trying to get rid of that.

Ms. SIMPSON. What he is saying is correct, that one shouldn't oversell the new equipment to say it will directly detect echoes and tornadoes all the way out to its 200 or 300 kilometer range. What he says is absolutely correct, but there is another aspect of the upgrade in technology in the making of the smaller-scale models which requires research input, that we will be able to do a much better job of forecasting 6 to 12 hours in advance where to watch out for these things, and what we are able to detect will be at least doubled over what we have right now with the old WSR-57's.

Mr. SCHEUER. Well, Mr. Quadros, I would appreciate if you would make those studies and reports available to us, and we will be happy to talk to you about it.

Mr. QUADROS. Certainly.

Mr. SCHEUER. If there are going to be gaps or our antennae are going to be quivering, we don't want that.

We had a gap caused by other reasons in North Carolina last fall with disastrous results. We really want to stop that, and we want to do it with as cost-effective use of manpower as we possibly can achieve.

We are not primarily interested in saving jobs. That time has gone forever. We are interested in producing cost-effective services and using the state-of-the-art technology to improve the services and, hopefully, to make possible reductions in manpower. These are times of real constraints, and we are going to be in these times of—we are going to be suffering under these financial constraints for a long time to come. We have got to work ourselves out of the morass that we are in of $150 billion budget deficits and so forth. We really have to make every dollar that we spend scream for mercy—squeal for mercy. These programs have got to be cost-effective.

And, Dr. Simpson, I would suggest to you that you make a good point when you say that local weather stations should have the benefit of inputs and continuous recording of weather experience so that we have uninterrupted data; that's true. But that doesn't mean that we have to keep open every weather station from the point of view of recording data and entering it into the computer if there are other ways of achieving that. It may be that there is a university.

Ms. SIMPSON. Exactly.

Mr. SCHEUER. It may be that there are other sources of reporting data.

Ms. SIMPSON. There are other sources of data, and there are ways to make studies to see where it is the most essential to keep the record and put perhaps automatic stations in to replace manned stations.

Mr. SCHEUER. Right. So it may not be necessary to keep a weather station open, with all the labor and personnel costs attendant upon that, simply for the purpose of providing continuity of data, if that can be provided satisfactorily, competently, through other sources.

Ms. SIMPSON. Including space observation.

Mr. SCHEUER. Yes, yes.

Okay. This has been a very interesting panel, and we will look forward to receiving any advice and counsel you may have, Mr. Quadros, on the subject that we just discussed, and I thank you both very much. You have been very patient, very forebearing, and gave us excellent testimony. Thank you very much.

The committee is adjourned.

[Whereupon, at 12:23 p.m., the subcommittee was adjourned.]

APPENDIX

STATEMENT OF CONGRESSMAN WALLY HERGER
BEFORE THE HOUSE SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT
APRIL 4, 1989

I am extremely concerned about the National Oceanic and Atmospheric Administration's (NOAA) Strategic Plan for the Modernization and Associated Restructuring of the National Weather Service.

Although I am well aware of NOAA's efforts to meet the weather observation needs of our country in spite of fiscal restraints, I must emphasize my concern that the safety of my constituents not be jeopardized as a result. It is my understanding that NOAA's modernization plan includes the closing of the National Weather Service station at the Redding Municipal Airport in Northern California. According to the plan, the Redding area would gather its weather observation information from the Next Generation Weather Radars (NEXRAD) equipment located on the coast in Eureka, California.

Not only are the coastal weather patterns very different from those in the Redding area, but it is my understanding that the NEXRAD equipment will not function as effectively from further distances. I have been advised that at a 60 mile range NEXRAD can gather data from the top of the atmosphere and down to 4,000 feet. At a 125 mile range NEXRAD cannot gather information below 10,000 feet. Redding is located 160 miles away from the proposed location of the equipment, with the peaks of the Klamath Mountains lying between the two cities with elevations ranging from 7,500 to 9,050 feet. This year alone, two tornadoes have been cited in the Redding area along with five funnel clouds just in the last few weeks. I question whether or not radar located 160 miles away over mountainous terrain would have detected these severe weather patterns accurately.

The Redding Municipal Airport is the focal point for air transportation to the entire north state seven counties with a population base exceeding 450,000. It is geographically in the center of the ground transportation network of highways, railroads and at the headwaters of the Sacramento River. It is the largest weather station scheduled to be closed in the modernization plan west of the Mississippi.

Accurate and constant weather coverage of the seasonal fires and winter flood and snow conditions is critical to the survival of the agricultural and timber industries in Northern California. Even with the present coverage, well over 700,000 acres of forests were burned in the last two years. The economic community dependent on the timber in this region cannot afford a additional burned acreage due to insufficient weather observation coverage.

Support of the agriculture and forestry industries would not only be excluded from the modernization plan in the Redding area, but I understand that this year's budget request calls for

elimination of the agriculture coverage as of October 1, 1989 and fire weather support would be limited to federal agencies.

It is my understanding that the Secretary of Commerce has assured the Congress that no weather stations will be closed until it can be aptly demonstrated and certified that services have not been diminished and that the safety of our air traffic is not jeopardized. In light of these concerns, I urge you not to approve a plan that would close the National Weather Station at the Redding Airport and eliminate the agriculture and wildfire reporting, but to ensure that this area of Northern California is receiving adequate weather observation coverage.

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U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUITE 2321 RAYBURN HOUSE OFFICE BUILDING
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August 16, 1988

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Republican Staff Director

Dr. William E. Evans, Administrator
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Washington, D.C. 20230

Dear Dr. Evans:

The National Climatic Data Center in Ashville, North Carolina, as you know, provides climatological data, archived weather information, and related products to a large and diverse user community. Many of my constituents are customers of the National Climatic Data Center, and they pay substantial amounts of money every year for the data available through the center.

I understand that it has become increasingly difficult to do business with the National Climatic Data Center. As a result of a decrease in staff available to serve the public, phone lines are busy, callers are placed on hold for an excessive length of time, and service is deteriorating more and more each day. I understand that as many as 20,000 fewer phone requests will be handled this year due to the staffing problems at the center.

I would appreciate hearing from you in regard to the staffing situation at the National Climatic Data Center, and on your plans to improve service and to assure that phone requests receive prompt attention.

Thank you for your consideration of my request.

Sincerely,

JAMES H. SCHEUER
Chairman
Subcommittee on Natural Resources,
Agriculture Research and Environment

UNITED STATES DEPARTMENT OF COMMERCE
The Under Secretary for
Oceans and Atmosphere
Washington, D.C. 20230

SEP 1 6

Honorable James H. Scheuer
Chairman, Subcommittee on Natural Resources,
Agriculture Research and Environment
Committee on Science, Space, and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

Thank you for your letter regarding services provided by the National Climatic Data Center (NCDC). We are taking steps to improve user services. The Center is in the process of installing a new telephone system that will expedite customer requests. The system will automatically answer all calls and allow customers with push-button telephones to have their requests directed to the appropriate program office within the Center. Meanwhile, NCDC is considering alternative user services staffing options for the coming fiscal year that can best meet NCDC customer requirements.

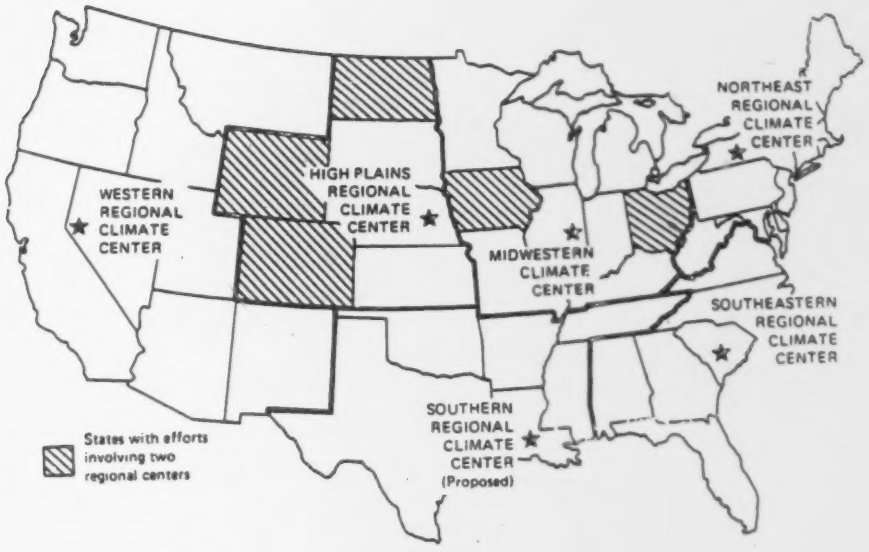
Please express to your constituents both our apologies for the inconvenience they have endured, and our gratitude for their support to NOAA's data and information programs. I am confident that the telephone problems will soon be alleviated, and NCDC will once again provide the fine customer service we all expect.

Sincerely,

William E. Evans

REGIONAL CLIMATE CENTERS

INSTITUTIONS TO ENHANCE CLIMATE SERVICES IN THE UNITED STATES



BOUNDARIES OF EXISTING AND PROPOSED REGIONAL CLIMATE CENTERS, BASED ON RESPONSIBILITIES FOR MAINTAINING REGIONAL DATA BASES

March 1989

THE PROBLEM

The U.S. National Climate Program was established by an Act of Congress in 1978 (PL95-367) to "assist the nation and the world to understand and respond to natural and man-induced climate processes and their implications." This major policy statement relating to climate and its dimensions resulted from growing concern over the consequences of climate fluctuations, coupled with awareness that two key climate issues were being inadequately addressed. These issues were major components of the Act.

Data and Information Services. The widely observed lack of reaction to climate problems and use of climate data and information were attributed to many factors including:

- inability of decision makers to understand and use climate data;
- slowness with which climate data/information were delivered;
- the poor quality of much climate data;
- inability of users to obtain desired types of climate data on the space scale needed; and
- inability to access available data sets held by states, private sector, and certain federal entities.

Climate Impact Assessment. Congress and scientists recognized in the early 1980's that the United States had too little understanding of how climate impacted society and the environment, and this prevented wise decisions about how to react to climate. Since climate by its nature tends to assume "regional dimensions," many studies of climate impacts and adjustments by public and private sectors need to be performed on a regional basis. The recent severe droughts and the earlier wet periods leading to the record high levels of the Great Lakes and the Great Salt Lake are typical illustrations of regional-scale climate phenomena experienced in the United States.

In essence there was a "missing link" in the nation's climate services system, involving data acquisition, archival, information generation, and delivery; and there was also a "vacuum" in the climate studies area relating to interdisciplinary regional scale studies.

THE SOLUTION

The inability to enhance the national efforts in climate services and in climate impacts research led to a new institutional concept: *Regional Climate Centers*. These centers, conceived as a flexible and innovative institution to address these issues, could be established nationwide; hence, providing a new means to address national needs for enhanced climate services, and to provide focused climate impact assessment efforts.

The Evolution of Regional Climate Centers

The concept of regional climate centers was developed by agricultural and climatological scientists during 1980-1982. Two test centers with differing missions were established, one in the Midwest and one in the Northeast, as demonstration projects to test the concept. The National Climate Program Office (NCPO) funded these centers, both as small efforts, and support continued through 1986. NCPO also provided funds to a Nebraska group to develop and test a climate information delivery system (based on a network of automatic weather stations in and around Nebraska) designed to assist agricultural operations in the central High Plains. By 1986, annual funding available from NCPO for these three regional demonstration efforts remained limited, namely only $200,000.

The rapidly growing interest in the regional center concept and their real and envisioned benefits were noted by Congress. Funds were added to the NOAA FY86 budget to initiate a Western Regional Climate Center in Nevada. Congress subsequently added funds to NOAA's FY87 budget for the Midwest Climate Center in Illinois, the High Plains Regional Climate Center in Nebraska, and the Western Regional Climate Center in Nevada. The merits of the regional centers were recognized by both the public and private sectors. This led Congress to provide additional funding of $1.28 million for four regional climate centers in FY88, including the one in the Northeast. In FY89 Congress provided $1.5 million for five centers including a new one established in South Carolina to serve the southeastern U.S.

FUNCTIONS OF REGIONAL CLIMATE CENTERS

Since the regional climate centers by design are located in different physiographic, economic, and climatic regions, their activities vary somewhat to match regional needs but their central functions are similar. The centers, in concert with NOAA climate entities, have identified their principal functions.

All centers perform activities in three major functional areas:

- Services including provision of climate data and information to all states and private sector interests; provision of expertise on climatic issues and assist in regional education relating to climate.
- Applied climate research including monitoring of anomalous conditions, performance of studies, and the enhancement of regional research.
- Data management including acquisition and development of specialized climate data sets.

Other functions are performed at certain centers to meet specific regional needs. For example, the Midwestern and High Plains Centers focus their service efforts around computer-based systems that provide near real-time climate data and information primarily for agricultural interests.

In order for states to be members of the regional programs, they must provide some form of services in turn for access to or provision of climatic data, information, and/or equipment from the regional centers. The regional centers are providing, to all states that wish to cooperate, computer equipment, software, and training (if needed) so that climatologists in each state have uniform capabilities. This serves to ensure a nationally informed means for timely data exchange and analyses. In certain states, automatic weather stations are being provided to enhance acquisition of key, unavailable data and to speed information generation. It should be recognized that some states do not have any organized climatological functions. In such situations, regional centers supply the basic common climatic needs (data/information/expertise) of all states in the region, and are responsible for maintaining a regional data base.

BENEFITS AND BENEFICIARIES

The beneficiaries of regional centers vary greatly, depending upon the climate and the economy of a region. However, four major beneficiary areas have been identified.

One is the climate-sensitive private sector: this includes agribusinesses, the energy industry, transportation, construction, and tourism. These businesses purchase data, secure climate information from the near real-time data systems, and have supported regional workshops and impact studies.

The second area of benefits relates to state government. Most states have a person identified as a "state climatologist" to perform certain climate services, but the amount of state support varies greatly. The regional climate centers provide data and information to these climatologists as well as to other state agencies including those involved in water resources design and management, environmental protection, conservation, and agriculture. A third major beneficiary is the federal government. The regional climate centers with their expertise and knowledge perform a wide variety of services for federal agencies. Many entities of NOAA (NCPO, CAC, and NCDC) are major beneficiaries. Similarly, USDA, DOE, COE, and EPA benefit by the expertise and applied studies of regional centers. The centers are serving as a key data-information linkage between federal entities typically housed in Washington, and the state government entities. The centers also aid federal agencies which maintain offices in the states and regions. For example, the state and regional offices of the BLM, Forest Service, SDS, COE, EPA, and the USGS are among the users of the regional climate centers.

The fourth major beneficiaries are the nation's citizens. The outreach education extension service activities of the regional climate centers, as part of the services function, are designed to enhance the general understanding of climate.

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STATUS AND BUDGET

In the spring of 1989 the five Regional Climate Centers are operating and serving 43 states. Three have had a 3-year period of development and enhancement; a fourth was developed over the last two years; and the fifth is just getting started. Plans to form 2 more centers, one in the south and one in Alaska are developing.

The National Climate Program Office developed, utilizing about 20% of their total annual budget (or $200,000), the regional centers concept. This, along with state contributions of $100,000 annually, got demonstration efforts started in Illinois, Nebraska and New York. These tests during 1982-1986 revealed that centers were viable institutions. However, it also revealed that to obtain a reasonable level of value and utility, more funding was needed, both from the federal government and state governments. State contributions involving personnel, facilities, and funds account for approximately 30% of the needed resources. At this time, the federal contribution is approximately 70%. This balance reflects the fact the regional centers are in the national interest. Only sustained federal support can ensure the continuing service and monitoring of regional climate conditions.

The regional centers also view the private sector as a developing partner. The private sector will become a major contributor to the support of a fully developed national program. As climate products come on-line at the new centers throughout the nation, the private sector will be purchasing the data and information products of the centers. This has begun at certain centers. The private sector will also be supporting applied research dealing with regional problems, and are already contributing to the conduct of conferences and symposia that focus on climate issues of concern.

FY90 REQUEST FOR FUNDS

Last year (FY89) the Regional Climate Centers asked Congress for a base funding level of $350,000 per center, a 9% increase over that approved for FY88 ($320,000 each). Through various budget adjustments applied by Congress and then NOAA, this was reduced to only $280,000, a substantial and unexpected reduction (12%). This occurred as the centers were in the process of expanding their services and employing high quality staff. The drought of 1988 also brought new and unexpected demands for information and calls for studies by the regional centers. For these reasons, the centers request a base funding of $375,000 each for FY90. This value for the five centers totals $1.875 million.

The rapid emergence of the regional centers as sources of expertise and leadership, climate data, and regional research has led to extensive requests to provide funding and added informational services to the states. The centers have also recognized major opportunities to collect, quality control, and interpret data in a more timely fashion for a variety of public and private sector applications. The five regional centers have assessed these requests and opportunities, and concluded that a **One-Time Upgrade** of funds is necessary to provide the level of services desired in the region and the attention to critical climate issues. These special regional needs include:

1. More state climate data obtained and delivered to the regional centers on a daily basis from existing weather observers (who normally report by mail monthly) or from automated weather stations strategically placed in areas without weather stations (requires communication faciliities, weather stations and allied facilities).

2. Resources to the states and their qualified institutions to perform joint regional research involving the impacts of climate research on water resources, agriculture, and energy, and studies on effects of climate change (funds, workshops, and guidance).

3. Development of regional information systems connecting state agencies to regional centers for high speed data and information exchange, and from the regional centers to federal centers (cabling, computers, and related support facilities).

4. Provision of more climate information to local, state, and federal agencies on special regionally sensitive issues like the drought of 1987-1988 (research facilities and publications).

This Upgrade will require $1,250,000 (250,000 at each center).

FY90 REQUEST FOR FUNDS

Regional Climate Center Operations	Base	One-Time Upgrade
High Plains Regional Climate Center (Nebraska)	$375,000	$250,000
Midwestern Regional Climate Center (Illinois)	$375,000	$250,000
Northeast Regional Climate Center (New York)	$375,000	$250,000
Southeastern Regional Climate Center (South Carolina)	$375,000	$250,000
Western Regional Climate Center (Nevada)	$375,000	$250,000
Subtotal	$1,875,000	$1,250,000
TOTAL	$3,125,000	

FEDERAL FUNDING HISTORY FOR REGIONAL CLIMATE CENTERS[1]

(Values are dollars in thousands)

FISCAL YEAR	MIDWEST CENTER-ILLINOIS	NORTHEAST CENTER-NEW YORK	H G H PLAINS CENTER-NEBRASKA	WESTERN CENTER-NEVADA	SOUTH-EASTERN CENTER SOUTH CAROLINA
FY-84	105	35	90	-	-
FY-84	90	70	40	-	-
FY-86	35	35	40	404*	-
FY-87	235*	76	235*	612*	-
FY-88*	267[2]	267[2]	267[2]	267[2]	-
FY-89*	280[3]	280[3]	280[3]	280[3]	280[3]

*Funds appropriated by Congress to the NOAA budget.
[1]State support from the institutions housing the centers, plus that of member states in the regions, has represented between 25% and 35% of the federal funding in each year.
[2]Congress appropriated $320,000; and NOAA has reprogrammed $53,000 ($212,000 total) from each leaving the indicated amounts.
[3]Congress appropriated $300,000 (after applying G-R-H reductions) and NOAA reprogrammed $20,000 from each ($100,000 total) leaving the indicated.

HIGH PLAINS CLIMATE CENTER

The High Plains Climate Center (HPCC) was formed in early 1987 by charter members in the states of Colorado, Iowa, Kansas, Nebraska, South Dakota, and Wyoming. North Dakota joined HPCC in 1988, bringing the membership to seven of the major Universities in the cooperating states: Colorado State University, Iowa State University, Kansas State University, University of Nebraska, North Dakota State University, South Dakota State University, and University of Wyoming.

Offices of the High Plains Climate Center are located at the University of Nebraska in Lincoln, and Dr. Kenneth G. Hubbard is HPCC Director. Each member institute appoints both a technical and an administrative representative to the Center.

HPCC works closely with other regional and federal climate centers on elements of the national climate program and provides a linkage mechanism for the Federal, state, and private sector climate activities to help bridge the gap between climate research and climate applications in the United States. The long-term objectives of the High Plains Climate Center are: to carry out applied climate studies, to develop improved climate products, and to provide climate services in the High Plains Region.

HPCC activities have included developing a special automated weather station network; implementing soil moisture and drought monitoring in the region; developing common linkages between federal agencies and stations in the High Plains Region; and developing computer systems and other climate software to perform important climate-related information dissemination.

HPCC staff were able to use recently developed soil water monitoring tools during the 1988 drought together with the High Plains Regional Automated Weather Data Network to monitor the drought impacts and to prepare special advisories.

HPCC also operates a dial-up information service for users of climate and weather data in the region. Data from 70 automated weather stations that collect hourly and daily measurements and from all National Weather Service daily reporting stations is used to track Weather Effects on Temperature, Heat, Evapotranspiration, and Rainfall in the 7-state region. Information relating to crop water use, crop performance, pest development, livestock conditions, soil water, and heat indices is available in the WEATHER dial-up computer system.

Cooperation with federal climate centers has included sponsoring of CLICOM data base management systems for each state in the region together with the National Climatic Data Center. Current plans call for a joint program with the Climate Analysis Center to identify climate impacts in the High Plains Region in a timely fashion.

MIDWESTERN CLIMATE CENTER

The Midwestern Climate Center is located at the Illinois State Water Survey and serves a nine-state region. The Center has three main components. A **data delivery system** is being developed to collect real-time weather data and provide climate information delivery to the users in the nine states in the region. Relevant **climatic data bases** are being acquired and managed. These will be a mixture of existing data bases and new data bases designed to address specific problems. **Applied research** is being conducted on diverse climate issues. The research is being designed to define the key weather and climate factors that have impacts on agriculture, water resources, and the generation and consumption of energy. Current research primarily deals with agricultural and water resources issues. Energy applications will be phased in as the center develops.

The research component is intended to lead to information products applicable to specific climate-related issues or problems. The private agricultural sector is expected to be the primary user of the Midwestern Climate Center. A comprehensive study of how and why this group uses climate information was made five years ago and is a foundation on which many of the services and products are being developed. To serve the needs of this and other groups of users of climate data and information, a new interactive computer system is being developed within the center. This system has been named the MIdwestern Climate Information System (MICIS).

The Midwestern Climate Center provides six types of services to users in both the public and private sectors.

- Access to regional and perhaps national climate data bases.
- The provision, on a subscriber-pay basis, of near real-time climate data and information designed to serve the needs of users within the region.
- Expertise relating to climate data, climate information, and climate research.
- Funding and equipment to help develop compatible state weather station networks (particularly specialized ones, such as those collecting data important to agriculture), and to promote the exchange of data and cooperative research.
- Publications dealing with regional climate issues.
- Planning and coordination of regional and subregional research projects, of both basic and applied natures.

The Midwestern Climate Center works closely with federal agencies concerned with climate issues, such as the National Oceanic and Atmospheric Administration, the Corps of Engineers, the U.S. Department of Agriculture, and the U.S. Environmental Protection Agency. The center provides assistance to federal agencies in ways similar to those provided on a regional and state basis, and works with other federally sponsored regional climate, weather, water, and agricultural centers.

The Center works closely with the states and their climatologists in the region who wish to be cooperating members. The Center has established computer-based systems called CLICOM in all states throughout the region, and in turn, the cooperating states also serve as a source of climatic expertise to the states and assist them in planning and conducting climatic research.

NORTHEAST REGIONAL CLIMATE CENTER

The Northeast Regional Climate Center was established in 1982 at Cornell University in Ithaca, New York, to assist with and promote the collection and use of climate data in 12 northeastern states. The Northeast Center currently provides support and technical assistance to state climate programs in the states of Connecticut, Maine, New Hampshire, New Jersey, and New York, and actively promotes the development of climate services and research in the other states of the region - Delaware, Massachusetts, Maryland, Pennsylvania, Rhode Island, Vermont, and West Virginia. In those states whose size or resources cannot support an in-state program, the Northeast Regional Climate Center provides basic climate services and expertise.

The Northeast Center's basic commodities are: 1) climate data- temperature, precipitation, wind, evaporation, solar radiation, etc.; 2) information based on the analysis and interpretation of these data; and 3) research conducted by professional scientists. Accurate, long-term documentation of climatic conditions is essential for assessing climate changes and their environmental and economic impacts, for planning and the safe design of buildings, water supply and drainage systems, highways and bridges, and energy use. For operational planning and management of weather-sensitive systems and activities, up-to-date information on climatic conditions as well as forecasts of future conditions are necessary. For example, the emergence of agricultural insect pests during the growing season is related to accumulated heat units known as Growing Degree Days. Knowledge of year-to-date GDD's and expected accumulations over the next several days enables growers to efficiently schedule control measures.

The Northeast Regional Climate Center maintains a computer-based climate information system of continuously updated weather observations, forecasts, warnings and advisories, as well as an extensive database of both current and historical climate data for the northeastern states. Information in the database is available to any user through CLIMOD - Climate Information for Management and Operational Decisions - software system. The CLIMOD system was developed by the Northeast Center to provide users with direct, interactive access to regional weather and climate information.

The Northeast Regional Climate Center provides climate data and information in a variety of forms to a wide range of users throughout the Northeast. Each month the Northeast Center compiles and publishes summaries of climatic data from about 350 volunteer observers, National Weather Services offices, and special observing sites located in the states of Maine, New Hampshire, New York, and Vermont. Two publications, *Northern New England Climate* and *New York Climate*, are mailed to more than 600 subscribers about three weeks following the end of each month. The December issue includes a summary of data for the full year. Subscribers include: state and local government agencies, particularly those responsible for environmental quality, energy use, water resources management and outdoor recreation; local offices of federal agencies; university researchers; private consultants; and businesses involved in the production or distribution of agricultural products and energy.

In 1988, tens of thousands of users were provided with routine climate information by an automated telephone answering system. Almost 2000 interactive sessions are recorded on the CLIMOD system. Nearly 1000 individual mail and telephone requests for data, interpretive reports, and expert advice on climate problems were answered last year from business firms, public utilities, state and local government agencies, private consultants, federal agencies, university researchers, lawyers, and reporters from newspapers, and radio and television stations.

The Northeast Regional Climate Center conducts, supports, and coordinates research studies focusing on 1) characterization of regional climate and climate variability; 2) assessment of the impacts of climatic variations on agriculture, water resources, environmental quality, and energy needs; 3) development of new techniques for using climate data in planning and operational decision making; and 4) improvement of computerized methods of collecting, managing, and disseminating climate data and information. Current projects involve individual and cooperative efforts by faculty researchers at Cornell University, University of Connecticut, University of Maine, University of New Hampshire, and Rutgers University.

SOUTHEASTERN REGIONAL CLIMATE CENTER

The Southeast Regional Climate Center, located at Columbia, South Carolina, serves the six southeastern states of Virginia, North Carolina, South Carolina, Georgia, Florida, and Alabama. The purpose of the Center is to enhance the use of climatological information and services in order to better meet the climatological needs of the economy, public and private agencies, and the citizens of Southeast U.S.

The Southeast Regional Climate Center was established by Act of Congress during 1988 and is in the process of beginning full operation. A climatological needs assessment has been made of the six southeastern states and will be published within the next few months. Based on needs revealed in this assessment, the Center will cooperate in the strengthening of the climate programs of each state in the southeast. Specifically, the Center will develop and maintain a regional climate data base that can be easily accessed. The data base must be broad enough to meet the regional climatological user needs of the six states in the Southeast. Unpublished data as it becomes available will be added to the regional data base which will include historical climate records of temperature, rainfall, winds, visibility, storms, and other climate data needed by agriculture, industry, and public and private agencies.

Applied climatological research is also a prime focus of the Center. A special effort will be made to encourage research directed towards better use of climate information in regional planning, in day-to-day operations, and in identifying critical climate events that affect the welfare, safety, and well being of the public. Some of the subjects that need additional research are drought, the greenhouse effect, and sea level changes in southeastern U.S. There is a need for better methods to detect the beginning of drought, as well as a need to develop better ways of monitoring drought and its impacts. The Southeast has a long coastline that is particularly vulnerable to sea level change, to hurricanes, and winter storms. There is concern that due to the greenhouse effect, sea level, rainfall, temperature, and storm patterns will change.

The Center will also provide a variety of other regional climate services including:

1. The establishment of a near real-time regional climate data exchange network.

2. The promoting of a climatic data management system (CLICOM) in each of the six states. Special training will be given to each State Climatology Office in the use of CLICOM. This will provide a common basis for processing and exchanging climate data.

3. Issuing a periodic regional climate newsletter that will provide regional climate information as well as progress on regional climate research and other matters of common interest.

WESTERN REGIONAL CLIMATE CENTER

Since its formation in August 1986, the Western REgional Climate Center (WRCC) has made significant progress in many areas relating to its mission of "improving the dissemination and use of climatic data for the economic benefit of the United States."

The first step was to create an advisory board comprised of the State Climatologists from each of the eleven western states and to establish a communications network between their offices and the WRCC. This was accomplished by supplying each office with an IBM PC/AT computer system, with enhanced color graphics, modem, and printer. Creation of this system ensured a high, minimum standard of capability and compatibility throughout the Region and facilitated communication and data transfer.

The next step was to obtain all of the climatic data "relevant" to answering climatic questions in the West and to develop programs that would enable this data to be distributed quickly to all users. The WRCC can fill data requests within 24 hours in a variety of formats and media. This capability was made possible by significant computer program development and enhancements to the WRCC's VAX 11/780 computer hardware and software. In addition to the historical data obtained from the National Climatic Data Center (NCDC), and updates thereto, the WRCC also archives or has access to the Remote Automatic Weather Station (RAWS) data downlinked into the Boise Interagency Fire Center from some 450 sites scattered throughout the West and the 500 Snotel sites operated by the Soil Conservation Service. This data is further enhanced by participation in the National Science Foundation's Unidata program, through which weather data is downlinked directly into the WRCC's computer.

As this data and communications infrastructure was being put in place, interactions were begun with some of the major Federal Agencies, who play a significant role in the management of the West's natural resources. Close cooperation with these agencies resulted in the formation of the WRCC's Climatic Data Service Facility. This Facility is operated in cooperation with Dr. Myron Molnau, the Idaho State Climatologist, who developed the basis for the Facility's data management system at the University of Idaho. The Facility permits users to generate a variety of statistical reports from the climatic database. Typically these reports are used as input to engineering models that assist the Agencies in managing their resources.

In order to successfully manage our region's natural resources as well as monitor trends in climate on a global scale, it is imperative that the data be of the highest quality. To this end, the WRCC established a "data validation project." Under this project the data from the cooperative observers throughout the region are reviewed each month by the appropriate State Climatologist before they are published by NCDC. To assist the State Climatologists in their review, a special computer program was developed by Dr. Kelly Redmond, the Oregon State Climatologist, with funds provided by the WRCC. A workshop was held in Reno to provide hands-on training in the use of the program prior to its implementation on each of the computers in the 11-state network. This project has been in operation since January 1988 and the

improvement in data quality has been significant. Since these observations provide the foundation of this country's climatic record, it is absolutely necessary that this project be continued and that funds be appropriated for the validation of at least 30 years of historical data.

It should also be noted that the development of the Climatic Data Service Facility and the data validation project provides a cost-effective alternative to the numerous Federal Agencies in the West, whose mission is to manage resources rather than duplicate archival and data processing functions. It is anticipated that the Facility will also prove to be useful to the private sector, specifically power companies and agribusinesses.

As a result of the activities described above, it has become clear than an additional level of involvement is required for the successful management of our region's resources. This level consists of integrating satellite observations and weather data with historical climatic data to provide resource managers with a complete picture of what is happening at a given location and how that relates to past observations and practices. Quite often in the West, the resources being managed are at different elevations than the locations where climatic data is available. It is an on-going problem to identify sources of climatic data which are representative of the management region.

In order to address the above problem, it is the intent of the WRCC to request a one-time appropriation to obtain the facilities necessary to acquire and process multi-spectral data from polar-orbiting satellites. Securing this system now will enable scientists at the WRCC to develop the procedures required to solve this problem in the most cost-effective way, i.e., as opposed to the costs of purchasing and maintaining the many additional surface-based meteorological platforms necessary to gather the requisite data. As the technology of the earth observing system improves, the programs developed today can be readily modified to provide even better performance in the future with no additional or recurring capital expense.

A PLAN FOR

NATIONWIDE CLIMATE SERVICES AND APPLIED CLIMATOLOGY

SUMMARY

This document presents a plan for a new nationwide system of climate data and information services designed to:

- *Improve economic productivity, efficiency, and cost effectiveness of U.S. agriculture, business, and industry through enhanced use of climate information.*
- *Provide reliable and consistent long-term information on the state of the atmosphere for use in management and public policy decision-making.*

The system builds on existing federal, state, and private sector capabilities to provide these services. A new institutional system, REGIONAL CLIMATE CENTERS, is proposed which, together with advanced technology, will provide timely and cost-effective climate services to all regions and economic sectors of the nation.

The development of climate services to the present is traced. Federal and state responsibilities for climate services, and the legislative basis for strengthening climate services, are summarized. The proposal assumes a strong partnership of federal and state governments, and interaction with the private sector in providing climate services and carrying out applied climate research.

Extensive drought conditions in the Great Plains and Southeast United States in the early summer of 1988 underscore the need to modernize climate services in the United States. Droughts are a recurrent phenomena of the climate of the United States and the ability to monitor, predict, and assess drought conditions is essential for efficient resource and environmental management. The proposal provides an approach for organizing climatological resources to aid individual decision-making and public policy actions in response to climatic variability and extremes, including regional drought.

The new system will enhance and create a focus for APPLIED CLIMATOLOGY in the United States.

Prepared by:
National Climate Program Office/NOAA,
National Climatic Data Center/NOAA,
Climate Analysis Center/NOAA, and
Regional Climate Centers
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A PLAN FOR NATIONWIDE CLIMATE SERVICES AND APPLIED CLIMATOLOGY[1]

1. Introduction

It is a goal of the National Climate Program to:

[1] Improve the economic productivity, efficiency, and cost effectiveness of U.S. agriculture, business, and industry through enhanced use of climate information,

[2] Provide reliable and consistent long-term information on the state of the atmosphere for use in management and public policy decision-making.

The system for climate services presented in this report contributes to the achievement of these goals, and addresses problems confronting users and managers of climate data. The approach presented links producers and users of climate services through data management, analysis, and delivery, and provides for internal and external feedback to keep the system responsive to user requirements and to opportunities offered by technological improvements. Attention is given to ways for engaging the private sector in developing and providing value-added climate services. A plan for research cooperation between publicly-funded climate data management organizations and private sector suppliers of climate services is presented. Improvements in the acquisition, dissemination, and application of climate data will serve to increase the focus on applied climatology in the United States.

Planned actions are listed in Section 7.

2. Background

2.1 Growth of Climate Service

Climate services in the United States have been an integral part of the nation's atmospheric programs since the early days of the U.S. Weather Bureau, now the National Weather Service (NWS). Early efforts of the Weather Bureau provided climate information which became the basis for planning and design of agricultural activities, transportation systems, and major structures built after 1900.

Computerization of climate data processing and professionalization of climate analysis began in the late 1940's. The National Weather Records Center, now the National Climatic Data Center (NCDC), was created in 1952 in recognition of the need for a national climate data archive to help monitor and describe the climate of the United States. Federal climate studies were augmented by a federally-funded

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[1] Hereafter "climate services" includes data acquisition, management, and dissemination, and "applied climatology" includes climate research, climate impact assessment, and use of climate information in business and policy decisions.

state climatology program between 1954 and 1973. The *Climatic Atlas of the United States*, was published in 1968.

Despite early recognition of the importance of climate information, climate data systems and services experienced a general deterioration in the past two decades. Federal planning and resources for climate data management and services failed to keep pace with the growth in volume of data collected by new observing systems; state efforts to provide climate services often were inadequate to fill the gap caused by termination of the federal state climatology program; and the private sector has been slow to develop and market value-added climate data and information products.

2.2 Federal-State and Private Sector Systems

Federal Climate Data and Analysis Centers

Federal climate services for the civilian sectors of the economy are rendered by components of the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), mainly through two centers serving, respectively, needs for retrospective and current climate information.

(1) The National Climatic Data Center (NCDC) of NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) has basic responsibility to collect, archive, process, and disseminate climatological data; to develop analytical and descriptive products to meet user needs; and to provide historical analyses and interpretations of climatological data.

Several types of climate analysis depend on observations made by over 10,000 cooperative observers who record daily temperatures and precipitation and send the observation, in paper form, to NCDC at the end of each month. The subsequent digitizing and quality controlling of these data by NCDC occurs several weeks after the data are received. Monthly summaries for each state are available 45-100 days after the end of the month.

Extensive selections and summaries of climatological data are published monthly and for various longer periods by NCDC to meet user requirements. NCDC received many direct requests for climatic data. In 1986, NCDC answered about 95,000 such requests, a record number and about 7,000 more than the year before. Further details for the availability of data products and services provided by NCDC are given in *Selective Guide to Climate Data Sources*, and *Environmental Information Summaries C-1* through *C-26* (documents available from NCDC).

(2) The National Weather Service's Climate Analysis Center (CAC) is organized to maintain a continuous watch on short-term climate fluctuations, and to diagnose and predict them. The work of CAC is designed to assist organizations both inside and outside the government in coping with such climate-related problems as food supply, energy allocation, and water resources. Products include monthly and seasonal outlooks, and weekly and monthly analyses including those published jointly by the U.S. Department of Agriculture and the CAC in the *Weekly Weather and Crop Bulletin*. Further details on CAC products and communication systems are given in Finger, F.G., Laver, J.D., Bergman, K.H., and Patterson, V.L., 1985, The Climate Analysis Center's User Information Service, *Bulletin of the American Meteorological Society*, 66(4), 413-420.

New technologies and institutional arrangements are being used to reduce the time between collecting and distributing these climate data. Where implemented, such as in the Midwest, a variety of climate data (air and soil temperature, precipitation, wind conditions, relative humidity, solar radiation) are available almost immediately and can be used for near real-time monitoring and management of natural resources.

State Climatologists

Most states have designated a state climatologist, some being nominal appointments at state universities and others being authorized by state legislation and funded at state agencies or universities. State programs range from very active to minimal, depending on a variety of circumstances in individual states.

Many states collect and manage climate data which are not retained in federal archives. Many state climate offices exchange climate data and products with other states and the federal centers (NCDC and CAC) but no provision existed until recently for regional data collection and analysis.

Interaction of state climate offices and federal centers has been mainly through the sending of specialized information to the federal centers of processed and summarized information.

Private Sector

Climate-related services by the private sector, mostly data and value-added information products, are appearing in response to technology improvements and growing demand for specialized climate services.

Some private sector firms operate data collection networks to meet their own or their customer's needs. These data are not likely to be found in either state or federal archives. For the most part, private sector users of climate data depend on data originating from networks operated by the Federal Government simply because this is the main source. The climate service role for which the private sector is uniquely suited is in developing and marketing specialized or value-added climate products. This may require specialized data; thus it is important to establish communication between these suppliers and the various public sources of data. Appropriate cost-sharing of reimbursement are needed to complete the integration of public and private sector climate service activities.

2.3 National Climate Program Act

In 1978 the U.S. Congress passed the National Climate Program Act (PL 95-367) which aimed at "assisting the nation and the world to understand and respond to natural and man-induced climate processes and their implications."

The NCP Act resulted from growing concerns over the consequences of climate fluctuations coupled with awareness that key issues relating to climate were being inadequately addressed in the United States. In particular, climate data users highlighted the need to improve the delivery and use of climate data and information. The Act formally established an intergovernmental climate program aimed directly at addressing many of the problems defined above.

Since passage of the NCP Act, there has been progress in improving climate service. But, even in an age attuned to the use of information, there remain obvious benefits not achieved, including those to the nation's economy and those related to environmental management. Efforts to realize these benefits has led to the formation of Regional Climate Centers (RCC).

2.4 Recommendations of the National Academy of Sciences (NAS)

NAS has actively participated in initiating and developing the National Climate Program through workshops and study panels. Many of their recommendations have been incorporated in the draft *National Climate Program Five Year Plan, 1988-1992.*

The Panel on Intergovernmental Climate Programs (*Meeting the Challenge of Climate*, NAS, 1982) recommended that the National Climate Program Office take a leadership role in the development and support of a coordinated, nationwide system of climate services involving both the public and private sectors through collaboration with existing state and regional climate programs and by encouraging the further development of such programs.

An NAS review of the National Climate Program, (*The National Climate Program: Early Achievements and Future Directions*, NAS, 1985) recommended (regarding climate data, information and services) that NOAA:

- *modernize its capabilities to manage the national climate data base,*
- *implement NCPO plans for a nationwide system of climate services, and*
- *involve the private sector in planning climate and weather services, allow unrestricted access to publicly-collected weather and climate data at a fair market price, and allow the private sector to compete for services in both the commercial and government market place.*

Another NAS review by the Panel on Climate-Related Data (*Atmospheric Climate Data, Problems, and Promises*, NAS, 1986) conducted a broad review of state, regional, and federal systems for climate data management. The Panel concluded its review with recommendations for improving management of weather and climate data based on perceived needs for:

- *an integrated national policy recognizing federal responsibility for climate data management, ranging from data acquisition to the provision of climate information and services;*
- *improved coordination by NOAA of its weather and climate data activities;*
- *a central data officer in NOAA with broad responsibility to coordinate weather and climate data management within NOAA and between NOAA and other agencies; and*
- *active federal promotion of the application of weather and climate data in both the public and private sectors.*

Many of the recommendations of these NAS studies generally have been incorporated in the framework presented in the report.

2.5 New Demands for Climate Data and Information

A synthesis of the major demands of climate users and data managers follows:

- *Climate data and information must be delivered in a more timely fashion.*
- *Climate data are needed on an increased range of space time scales.*
- *Climate data need to be higher quality.*
- *Climate data need to be available in more usable formats.*
- *Access is needed to climate data held by the private sector, states, regions and some federal agencies.*
- *Interpretation and effective use of climate data needs to be increased for decision makers.*
- *The private sector needs to develop and market value-added climate and information products.*

There are significant data access problems for both users and suppliers of climate services. Many users, including some state and local offices of federal agencies, lack a convenient source of climate data and services, or perhaps even knowledge of where and how climate data and information may be obtained, and how to apply data to specific problems. Federal agencies that supply climate services have no systematic way to acquire data from monitoring networks operated by state agencies concerned with agriculture, air quality, forests, transportation, water resources, and other vital activities. Also, there are no consistent standards among the states for archiving climate data from state or local networks.

In addition, there are gaps in geographic coverage by federal, state, and other observational networks, usually in sparsely-populated areas. Variability in data quality is especially troublesome. Inconsistencies in application of siting standards, observational procedures, processing methods, and product formats impede effective quality control and effective climate services.

User feedback is generally addressed by suppliers on an ad hoc basis. Organized user conferences have been rare in recent years. One recent study systematically examined agribusiness use of climate services (Lamb, P.J., Sonka, S.T., and Changnon, S.A., Use of Climatic Information by U.S. Agribusiness. NOAA Technical Report NCPO 001, 1985). Similarly thorough and up-to-date studies are needed for other major user groups such as energy, industry, and water resources planning interests.

Most of the obstacles listed above are well-known and actions have been taken to overcome them. For example, NOAA's National Environmental Data Referral Service (NEDRES) computer-searchable data base identifies the existence, location, characteristics, and availability of climatic and environmental data. The data base is accessed by a local telephone call using a computer terminal or personal computer. A search is made using any word desired by the caller, and the results can be listed on the caller's terminal or printed at the computer site. NEDRES describes the data and directs the caller to the holder of the data. Periodic updates of the data descriptions in NEDRES are a continuing objective for all participating organizations holding climatic data in any form.

In an effort to reduce the time required to manually record and transmit climate data, the NWS is experimenting with daily telephone communication of observations made by cooperative observers, and with automated surface observation systems at airports. The RCC's (Section 4) are developing systems to

deliver, in near real-time, these and other data rapidly collected, analyzed, and interpreted for their climatic importance.

These and other examples notwithstanding, several reviews of the nation's climate service system have shown that the existing organization of federal, state, and private sector climate services is inadequate to address the problems listed at the beginning of this section. Some innovation, reorganization and redefinition of directions are needed.

The following framework is a first step toward the realization of a new climate service system in the United States.

3. Principles of Climate Service System

The development of a new system of climate services is based on the following principles:

1) *A federal, state, and private sector partnership is needed to:*

a) maximize data coverage and availability;

b) provide for feedback between collectors and users of climate information;

c) ensure that climate data are being used in an appropriate and effective way; and

d) provide continued education on the use and value of climate data.

2) *The collecting and archiving of climate data is a public responsibility.*

Most climate data are collected by federal networks and retained at federal archives; states operating specialized networks are responsible for assuring the quality of these data and providing repositories allowing ready access to the data. Many applications of climate data in business, in legal issues, and for resolving environmental questions require unbiased data collected by governmental agencies.

3) *Data collection, analysis, and applied climatological research are essential and integrated functions.*

"Coordination of [weather and climate] data activities requires constant attention at both the policy and working levels. There must be continual feedback and interaction among all the participants in the data system, including those responsible for observations, quality control, data analysis, data archiving, equipment procurement, and data dissemination. There must be recognition of the substantial and continuing value of climate data to the nation. There must also be an institutional mechanism for implementing and enforcing improvements." (NAS, 1988, p. 68).

3.1 Functions

The climate service system presented in this proposal consists of four functions linking the producer and end user of climate data and information products:

DATA MANAGEMENT: data collection and assembly, quality control, and archiving;

ANALYSIS: application of climate information, applied research, assessment of climate data trends, and development of value-added climate products;

DELIVERY: printed materials, electronic communications, and comprehensive outreach activities;

FEEDBACK: external interaction between users and suppliers of climate services, and internal interaction between collectors, processors and analysts of climate data.

A system that accomplishes these functions in a timely and cost effective manner will make a significant contribution to the Nation's economy. For example, existing technology now allows the collection and distribution of climate information in near real-time. Applications of this new form of climate information are only beginning to be developed, but already the range of uses has been extended to short-term decision-making in support of selected agricultural operations such as irrigation scheduling and timing of farming operations.

The new climate service system includes improvements in the operation of activities at federal centers, revised functions of some centers, enhancement of state programs, coordination of multiagency climate information systems, and development of regional climate centers, a new institution needed to facilitate the nationwide system.

4. Regional Climate Centers (RCC)[2]

4.1 Concept of Regional Climate Centers

Regional climate centers (RCC) were conceived as a flexible institution for merging certain responsibilities of federal and state climate service systems, and for meeting regional needs, not adequately served by the existing systems. RCC's fit within the framework of the federal, state, and private sectors mentioned above, and the RCC's facilitate the functions of all three of these basis entities.

RCC's are built on the principle that climate phenomena are regional and must be addressed on that basis. A necessary tool for that purpose is a regional climate data base, created from federal, state, and private climate data sets to address region and sub-region scale climate problems. RCC's are initiated by the states and they represent a joint federal and state commitment to support their operation. RCC's are centers of climate expertise able to address regional and local problems and to provide services to state and local offices of the Federal Government.

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[2] See "Regional Climate Centers, A New Institution for Climate Services in the United States," Oct. 1987, 12 pp., for more information about the centers.

4.2 Structure of Climate Regions

Six climate regions are delineated for the contiguous 48 states (figure 1). Four regions are active and two are proposed. Although the regions are large, each region has general homogeneity of climate, soils, and physiography.

Region boundaries are fixed for the purpose of developing and maintaining regional climate data bases. However, in keeping with the concept of a regional climate center as a flexible institution, research and impact assessment need not be confined by regional boundaries, but can be organized to include the region of concern.

4.3 Relation to Federal Agencies

In the overall framework for a national climate service system, RCC's offer technical and other support to state climatologists, act as focal points for multistate climate analyses and assessments, cooperate with specialized regional applied research groups, and serve as interfaces with the federal climate centers (NCDC and CAC) and NCPO. Specific responsibilities are:

- *develop or improve regional climate products and software to enhance data, applications, product display and communications (e.g., contributions to the CLICOM user group)*[3]
- *maintain regional data bases and updated inventories of regional data sources, including relevant satellite, environmental, hydrological, and other natural resources data;*
- *provide regional climate data to federal centers;*
- *archive specialized climate data from state, local, and private sector networks;*
- *coordinate applied climate research, and develop applications of climate data and information to meet regional and state needs;*
- *generate climate information from supplementary data sets not available in national archives; and*
- *organize and chair meetings of regional advisory groups.*

4.4 Relation to State Climatologists

Technical support of state climatologists is a basic RCC responsibility. Specific elements, as endorsed by the American Association of State Climatologists (AASC), include:

- *RCC focus on solving climate-sensitive problems affecting states in the region;*

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[3] CLICOM (climate computer) is a microcomputer and menu-driven software system for climate data management developed at NCDC for the World Meteorological Organization (WMO). The system is provided to developing countries by WMO. CLICOM is also being acquired by state climatologists and researchers in the U.S. for climate data management and research support.

Figure 1: Regional Climate Center locations

- *establishment of an advisory board of state climatologists in each region;*
- *development of products and procedures to facilitate application of recent research by state climatologists; and*
- *adoption of CLICOM as the standard data base system for both state climatologists and RCC's.*

4.5 User Advisory Groups

Regional climate centers maintain user advisory groups representing industry associations and public sector agencies which RCC's serve by providing climate data and related services. The function of the groups is to advise RCC directors and staffs on ways to improve climate services or to provide new services.

User advisory groups are to be distinct from bodies established to participate in managing the regional climate centers.

4.6 Cost-Sharing and Cost Recovery

Cost-Sharing

Regional climate centers, a partnership of federal and state government, is based on the principle that states are expected to contribute in-state costs associated with the collection, quality control, management, and dissemination of climate data and related services of regional climate centers. State cost shares include outlays for operation and capital investments, travel, communication, and personnel costs associated with regional climate center operations in the state.

Cost Recovery

Regional climate centers will charge or receive appropriate exchange for services provided to federal agencies and private sector users. States not participating in cost-sharing as described above are to be charged for climate data and related services provided by Regional Climate Centers. Charges should be set to recover direct costs associated with the data management function of the center.

5. Federal Climate Services

5.1 National Oceanic and Atmospheric Administration (NOAA)

NOAA's principal climate service activities are divided between two of its major components. Data archiving and retrospective climate services are the responsibility of the National Environmental Satellite, Data and Information Service (NESDIS) and are carried out through its National Climatic Data Center (NCDC), Asheville, NC. Long-range forecasting and current climate services are responsibilities

of the National Weather Service (NWS) and are carried out through its Climate Analysis Center (CAC) of the National Meteorological Center (NMC) in Washington, DC.

National Climatic Data Center (NCDC)

NCDC is responsible for collecting, archiving, and publishing data from national observational networks that have enduring value to the nation and are sufficient to describe the climate of the United States; and to archive data collected through international agreements and under the responsibilities as a World Data Center for Meteorology. The Center is also charged with the responsibility to disseminate or furnish climate information to users and requesters through routine scheduled publications and other holdings. NCDC is the official federal archive of climate data. The Center performs standard data quality control, maintains weather station histories and maintains continuity of data sets from major basic observing networks. For too long, however, the activities of NCDC have been directed mainly toward the management of climate data. Increased efforts at data analysis have begun with the development of long series historical climate network data for baseline data sets to establish climate trends and monitor changes.

In the new climate service system, NCDC will:

- *implement improved methods for collection, quality review, dissemination and sharing of climate data and information as new communication technology matures;*
- *augment the climate data base with long-term data sets as a baseline for determining climate trends and monitoring change;*
- *install the U.S. CLICOM system and aid users in operating the system with training and through a users group and newsletter;*
- *support a BITNET electronic mail/data delivery system directory and bulletin board for the climatological community; and*
- *speed the flow of cooperative observations to RCC's.*

Climate Analysis Center (CAC)

The CAC's mission is to develop and apply new methods for global and national analysis, diagnosis and prediction of mainly short-term (e.g., weekly, monthly, and seasonal) current climate fluctuations. This includes timely dissemination of current global and national climate information and products to a wide variety of users for climate impact assessments and other purposes.

In the new climate service system, CAC will:

- *develop a new National Climate Assessment Data Base (NCADB) suitable for national short-term climate assessment, integrating national, regional, state, and special-area observations of suitable quality available for near real-time use (see Section 6.3);*

- *use the NCADB and real-time regional products to develop new and enhance present national products, which are complementary to, and consistent with, regional climate products and conditions, and thus be more effectively used by RCC's and federal assessors; and*

- *improve availability and timeliness of short-term climate data and products, including graphics and summary data sets, using electronics communications and weekly and monthly publications.*

National Climate Program Office (NCPO)

NCPO is the lead entity responsible for administering the National Climate Program, including intergovernmental climate-related studies and services.

In the new climate service system, NCPO will:

- *Establish and chair a steering committee to coordinate overall planning and periodic reviews of nationwide climate services involving cooperation among federal climate centers, RCC's, state climate and the private sector;*

- *Encourage the continued growth of private sector participation in providing climate services;*

- *Devise and oversee tests of mechanisms for intergovernmental cooperation in providing climate services and conducting climate studies;*

- *Coordinate regional climate center plans and programs as a contributing element of nationwide climate services; and*

- *Prepare and submit annual budget requests to support nationwide climate services.*

5.2 U.S. Department of Agriculture (USDA)

Several USDA agencies, State Agricultural Experiment Stations (SAES), and State Cooperative Extension Services (CES) use or produce climate-related information and deliver this information to end users.

In the new climate service system, USDA agencies will:

- *Carry out applied research on the relation and effects of climate on biologic processes, and the productivity and management of soils and water resources;*

- *Produce and deliver specialized agricultural weather information for farmers and policy makers;*

- *Cooperate with RCC's and state climate offices in assessing users' requirements for climate data and information;*

- *Cooperate with RCC's and state climate offices in operating specialized weather data collection systems; and*

- *Cooperate in making climate data from agricultural and forestry weather research and operational networks available to RCC's.*

5.3 Other Federal Programs

Climate services will be added to or strengthened in other federal agency of federally-funded programs. For example:

- *The Department of Interior's U.S. Geological Survey (USGS) and the American Association of State Climatologists are planning to improve the content of USGS' national water summaries by systematically drawing upon the expertise of state climatologists.*
- *The Climate Analysis Center plans to explore with the Department of Energy the feasibility of jointly operating a facility specializing in timely climate analyses and assessments for energy management and planning problems.*
- *The Environmental Protection Agency is developing plans for global climate research and continuing air quality assessments, and has need for a wide range of climate data which it will obtain from NCDC, CAC, RCC's, and state climate offices.*
- *The University Council on Water Resources Research (UCOWRR) in drought response planning is planning a broad research program addressing climate impacts on U.S. water resources.*

6. Coordination of Climate Services

6.1 National Climate Program Office (NCPO)

NCPO has general responsibility for coordinating overall planning and periodic reviews, and specific responsibility for coordinating regional climate center plans and programs with other elements of nationwide climate services. This coordination will be achieved through:

- *A steering committee, chaired by NCPO, of regional climate center directors, and representatives of participating federal agencies. The committee will meet semi-annually to plan the program and review progress. Workshops and ad hoc meetings will be held as needed to address and resolve technical issues;*
- *Annual updates to the plan consisting of priority activities, budget, and schedule;*
- *Advisory groups established by each regional climate center which represent federal, state, and private sector users and suppliers of climate services;*
- *Adoption of the CLICOM system of data management to facilitate standardization of data management practices and contribute to more timely and efficient data exchange among centers and individual states; and*
- *Formalization of cooperation between NOAA and host institutions for the purpose of establishing and maintaining regional climate centers.*

6.2 National Climatic Data Center (NCDC)

NCDC will coordinate ongoing and developing climate services toward a goal of:

- *enhancing applied research, special climate analyses, and studies of impacts across regional boundaries by participating with scientists from regions and various committees;*
- *providing climate information to a larger private sector population;*
- *developing data exchange policy, standards, and products; and*
- *participating actively in the steering committee (Sec. 6.1).*

6.3 Climate Analysis Center (CAC)

The CAC is initiating coordination with RCC's, State Climatologists, and others in order to:

- *determine methods for integrating regional, state, and special-area networks of surface observations with federal observations in the National Climate Assessment Data Base mentioned in Section 5.1;*
- *help develop standards and procedures for quality assurance of data and products for current climate assessments;*
- *improve short-term climate assessments on a local, regional, national and international basis; and*
- *participate actively in the steering committee (Sec. 6.1).*

7. Program Implementation

The goal of this new system in climate services and applied climatology is to address needs listed in Section 2.5.

7.1 Timeliness of Climate Services

ISSUE: Delays in dissemination of retrospective and current products.

ACTION: (1) Increase use of "on-line" systems (NCDC, CAC).

(2) Improve data processing management, including use of CLICOM system to maximum feasible extent (NCDC, CAC, RCC's).

(3) Develop regional near real-time climate information systems (RCC's).

7.2 Spatial Scale of Climate Products

ISSUE: Inadequacy of federal weather observational network density for most weather elements.

ACTION: (1) Integrate state/regional automated surface observations with federal data systems to maximum feasible extent (NWS, RCC's).

(2) Encourage development of compatible state automated surface observing systems (NWS, RCC's).

7.3 Quality Control of Climate Data

ISSUE: Variability of climate data quality.

ACTION: (1) Further systematize assistance of State Climatologists in reviewing cooperative observations and flagging probable errors (NCDC and RCC's).

(2) Encourage early completion of study of siting and instrumentation standards by American Association of State Climatologists (AASC).

(3) As feasible, expand standards studies to other aspects such as archiving, analysis practices, and climate data communication protocols (CAC, NCDC, RCC's, state climatologists).

7.4 Access to Climate Data

ISSUE: It is often very difficult and time-consuming to acquire data from some specialized meteorological networks--federal, state, and private.

ACTION: (1) Develop cooperation arrangements and model procedures for data exchanges (RCC's and NCDC).

(2) Organize periodic updates of inputs to National Environmental Data Referral Service (NEDRES), an on-line computer searchable data base (NCDC).

7.5 Improving Use of Climate Information

ISSUE: Many decision-makers make little use of climate data in planning and operations. This is due in part to the comparatively small number of climate information products and application methods available, and in part because of limited skills in using what products and methods are available. A communications gap between producers and users of climate information products and methods makes the problem more serious.

ACTION: (1) Complete a comprehensive review of effectiveness of data and analyses provided to aid individual decision-making and public policy response to the 1988 drought (NOAA).

(2) Improve application skills through outreach education and training courses (state extension services, state climate offices, RCC's).

(3) Provide continuing two-way communication between producers and users of climate information through user advisory committees and outreach programs (RCC's, state climate offices, state extension services).

(4) Develop retrospective and current climate data discs or diskettes for interactive use on personal computers (NCDC and CAC).

7.6 Private sector participation in providing climate services

ISSUE: The private sector has been slow to develop and market climate services. Improvements in data management and communication technology, coupled with higher skill levels in applying climate information, should increase the demand for specialized climate services, thereby creating profit opportunities needed to attract private sector firms.

ACTION: Explore pricing and cost-recovery options for encouraging the private sector to develop the commercial market for specialized climate services while allowing the public sector to fill data requests and carry out applied climate research and impact assessments (NCDC, CAC, NCPO, RCC's).

A New Way to Forecast Next Season's Climate

A new mathematical technique that makes 90-day climate forecasts by searching the historic record does as well as humans

MANY A SELF-TAUGHT WEATHER FORECASTER has looked up at the sky and thought, "The last time it looked like this it rained the next day. It'll probably rain tomorrow." Now long-range forecasters are following suit by using a statistical system that considers the most recent season and then searches its 40-year memory of climates of the same season to find a close match. Whatever followed that best match becomes a forecast for the coming 90-day season.

This entirely objective analog technique performs as well as human forecasters have done over the past few decades, and it will soon get better still. Researchers hope that by adding the analog technique to the tools already available, they can contribute to a doubling of forecasting skill during the next few years. Everyone from the farmer wondering whether to plant his winter wheat to the natural gas supplier wondering how much gas to have on hand should be happy about that.

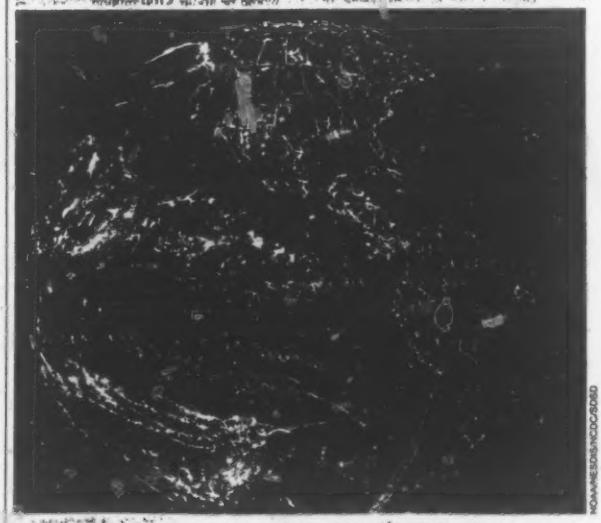
An improvement in skill would certainly be welcome considering the long-range forecaster's experience so far. Over 23 years the National Weather Service's forecasters have an average skill of 8% in predicting whether the temperature during the next 90 days will be near normal, below normal, or above normal. If they had done no better than chance, their skill would have 0%, and if they had been perfect, their skill would have been 100%. The 8% skill is equivalent to being right 38 times out of 99 when chance would account for being right 33 of those times. The skill of official forecasts of precipitation has been 4%.

Until recently, the types of forecasting tools available to the Prediction Branch of the Weather Service's Climate Analysis Center (CAC) for making 90-day forecasts had remained substantially unchanged for 25 years. Branch Chief Donald Gilman has described long-range forecasting as "an empirical art" and "a kind of cook's mixture of empirical techniques." Every month, several forecasters at CAC subjectively combine the results from a number of objective methods to produce a forecast. The methods range from an informed decision that the recent climate will persist through the next 3 months to deciphering how distant events such as El Niño's warming of the tropical Pacific will affect weather in the United States. The individual forecasts are then combined to form the official forecast.

The new analog technique is now one of the tools that CAC forecasters use routinely to predict temperature, a first in seasonal forecasting. The basic analog system from which the CAC version was derived was developed by Tim P. Barnett of Scripps Institution of Oceanography and the late Rudolph Preisendorfer. They showed how to boil down the many millions of weather observations from a 90-day period into a few numerically compact variables that can say something about the coming 90 days without overwhelming a forecast system. Most of the torrent of data that goes into computer models that forecast up to 7 days ahead has nothing to do with what can be predicted about the atmosphere on the scales of 90 days and thousands of kilometers. The analog system pares the observations down to a minimum while maximizing predictability.

Robert Livezey and Anthony Barnston of CAC improved the Barnett and Preisendorfer analog system by refining the kinds of observations included. They found that the three most critical variables are a measure of atmospheric circulation over the extratropical Northern Hemisphere, a particular index of the state of the El Niño cycle and its associated atmospheric oscillation, and U.S. surface temperatures. They included sea surface temperatures from five areas in the Caribbean and Pacific and a measure of lower atmosphere temperatures because they improved skill despite their close correlation with the other three. As it turned out, all five variables contributed to winter forecast skill, but only three contributed to summer forecasts and one each to spring or fall.

Barnston and Livezey also appended some additional steps to the original system. In their version, for example, after each fall season of the past 40 years has been compared with the most recent fall in terms of the distilled climate variables, the past seasons are ranked according to how good a



NOAA/NESDIS/NCDC/SSD

The weather puzzle to be solved. *Predicting the net effect of the complex and everchanging pattern of weather systems during the next 90 days is a formidable task. Long-range forecasters have a new, completely objective technique in which past records provide a guide to the coming season's weather.*

match they make. The ten best matches are weighted according to the closeness of the analogy and then combined. Livezey and Barnston also included an antianalog selection in the system. Instead of assuming that what followed a similar fall in the past will follow this fall, the antianalog method assumes the opposite: a fall that was a complete opposite would have been followed by a winter that was the opposite of the winter to be forecasted. The use of antianalogs in effect doubles the size of the sample from which comparisons can be made, a distinct advantage when seasons are so variable and the usable record so short.

In its present operational form, the analog system is as skillful as human forecasters have been during the past 25 years. When applied to past data, it had an all-season skill in predicting temperature of 8%, as did human forecasters. Like them, its greatest skill came in winter forecasting, in which it scored 16% to the humans' 18%. Both, therefore, exceeded the 10% winter skill achieved by predicting that the below, above, or near-normal character of the preceding season would persist through the next season.

With the analog system in operational use, Gilman and his colleagues at CAC hope to double their long-range skills within the next few years. Presumably, forecasters will be able to increase their skills by blending the objective skill of the analog system with their independent subjective skills. Improvements in the analog system itself are under way. The skill of a forecast that a weather pattern will persist seems to be independent of analog skill and is therefore being incorporated in the system. The usefulness of adding the correlation between sunspots, the quasi-periodic shift in stratospheric winds over the equator, and the weather (*Science*, 25 November 1988, p. 1124) is being tested as well.

There is another approach to improving the usefulness of predictions that forecasters at all ranges are now taking more seriously. It involves knowing when the forecast is going to be more trustworthy than usual and when it will be less so. In the case of long-range forecasting, skill is higher in winter than any other season, in the southeast United States than in the Great Plains, and in certain phases of the El Niño cycle than in others. Utilizing such "forecasts of opportunity" at all time scales will be the subject of a subsequent story.

■ RICHARD A. KERR

ADDITIONAL READING

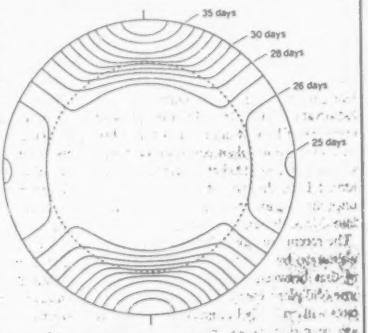
R. E. Livezey and A. G. Barnston, "An operational multifield analog/antianalog prediction system for the United States seasonal temperatures," *J. Geophys. Res.* 93, 10,953 (1988).

Gazing into the Interior of the Sun

In much the same way that terrestrial seismologists have probed the interior of the earth by mapping the way our planet vibrates after an earthquake, astrophysicist Kenneth G. Libbrecht of the California Institute of Technology has been probing the interior of the sun by mapping how great, slow vibrations move across the face of our star like waves on a glowing sea. His latest results could provide an important clue in one of the longest standing mysteries of solar physics: the differential rotation.

The word "differential" refers in this case to the fact that the sun's rotation rate decreases steadily from the equator, where the period is 25 days, to the poles, where the period is 36 days. (The sun is not constrained to rotate as a rigid body because it is actually a ball of gas.) Presumably, says Libbrecht, this pattern is the surface manifestation of some deeper pattern, which would in turn hold the key to the mystery if we could only find out what it is.

Enter helioseismology. For more than two decades now, says Libbrecht, solar



The sun in cross section. *The pattern of rotation derived from the Caltech data is shown here with contour lines of equal rotation rates. The dotted circle marks the lower boundary of the convection zone.*

physicists have known that the seemingly chaotic rise and fall of plasma on the surface of the sun is not chaotic at all. Rather, it is the result of sound waves reverberating through the 1.4-million-kilometer sphere like the overtones in a ringing bell. The sun is now thought to harbor about 10 million such waves, each with its own unique frequency. Whatever the origin of these waves—no one knows—solar astronomers have long recognized their potential as an observational tool: the longer their wavelength, the deeper they penetrate into the solar interior. Moreover, the difference in frequency between waves moving east and waves moving west is directly related to the rotation rate. So in principle, says Libbrecht, an analysis of the surface waves could tell us most of what we want to know about the inside.

In practice, that analysis has been hampered by the mountainous quantities of data required. Libbrecht and his students currently hold the record. But to win it, they spent 4 months at Caltech's Big Bear Solar Observatory taking one image of the sun every minute, for a total of 60,000 images. They then devoured at least as much Cray supercomputer time extracting the vibrational modes from the images and then converting that information into their model of the interior, which has the highest resolution yet attained.

Unfortunately, says Libbrecht, the data are not good enough to say anything about the inner 40% of the core. But what they do show very clearly is that the surface rotation rates extend 30% of the way inward, to just below the base of the sun's "convection zone." This is the region where the gaseous plasma is excited into violent, turbulent motion as it transfers heat from the hotter interior to the cooler surface. It is also the region that generates the sun's magnetic field. Below the convection zone, however, the sun seems to rotate almost rigidly, with a period of 27 days. This could be a key to the puzzle, says Libbrecht: "It confirms that the differential rotation is somehow being generated by convection." On the other hand, he says, "we don't understand convection." So thus far, it is only a clue. ■ M. MITCHELL WALDROP

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